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The Journal of
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Autumn 1980
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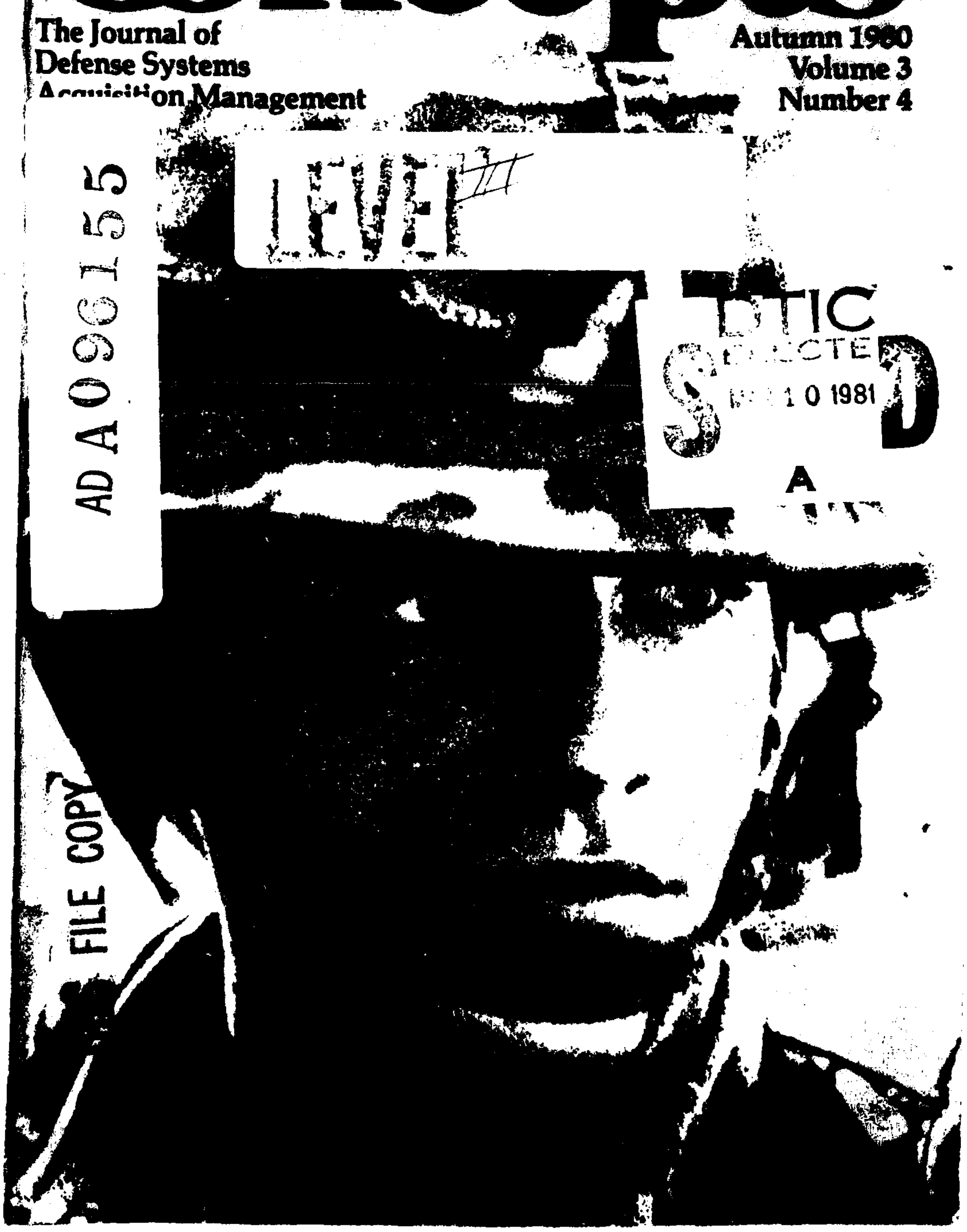

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from the editor . . .

With this issue, the Defense Systems Management Review *becomes* Concepts: *The Journal of Defense Systems Acquisition Management. The shorter title,* Concepts, *is itself a bit more manageable and a lot more representative of the fluid, creative, and idea-oriented nature of this critical business of developing and buying advanced military systems.*

It was no accident that we chose for the first cover illustration under our new name the face of a young lieutenant. Sometimes, in our fervent worship at the altar of advanced technology, we forget whom we're really working for. Sometimes we get so bound up in the juvenile parochialism that pits service against service in a needless and costly scramble for the "goodies" that we ignore the needs of the customer. Sometimes we chase the rainbow of the "perfect" system to the point that after years of work and billions of dollars in expense, all we can offer the guy in the field is a stack of four-color brochures and more promises. This isn't the way it should be, but it's the way it will be unless we focus all our work toward giving the user exactly what he needs to do the job, no more and certainly no less.

On another front, we have completed the conversion of our mailing list from a computerized system to a mechanical one. Because of the transient nature of our audience and because it's been so long since our list was completely updated, many of the addresses we're using now are wrong. Furthermore, mistakes can be, and are, made in making the new plates. To make a long story short (if it isn't too late), there may be a mistake in your address on this issue. If so, just drop us a note giving your correct address. Be sure to include your old address, or at least your old ZIP code, so we can locate and remove the incorrect plate.

With all that out of the way, just let me say that we hope you find something in this issue that causes you to think, either in cool reflection or in the heat of anger. The only way we can know if we're meeting your needs is for you to tell us. Let us hear from you.

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MICOM Project Management Manpower Model

Dr. William C. Wall, Jr.
David L. Stanbrough

The compelling need for normative, quantitative techniques of estimating manpower[1] requirements and of forecasting future manpower needs for project management offices (PMOs) is due primarily to three causes. First, current methods are heavily qualitative, involving, among other things, such irrelevant factors as emotion, personality, brochuresmanship, and just plain slick talking. Staffing typically is a function of what the traffic will bear with little attention being paid to meaningful quantitative factors. Second, we are facing the reality of continually decreasing manpower resources. This means we must reverse the trend in this nation of decreasing productivity and look more objectively at resource allocation. We must find ways to do more with fewer people.[2] Finally, we must apportion manpower resources fairly and accurately. If all PMOs are understaffed, it should be on an equitable basis—the hurt should be shared equivalently among them.

1. The term manpower is used throughout this article as a generic term referring to both female and male members of the work force.
2. An excellent discussion on the decreasing work force may be found in Thomas J. Gelli, "The Army's Vanishing Civilian Work Force," *Defense Management Journal* 16 (First Quarter 1980), pp. 61-64.

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The U.S. Army Missile Command (MICOM) recently took a significant and unique first step toward offsetting the purely qualitative aspects of determining the proper staffing levels for project management offices through development of a normative, quantitative approach to manpower apportionment. Intended ultimately as a zero-base or ground-up deterministic model, the MICOM Project Management Manpower Model (MPM^3) is currently operative as an apportionment model that will objectively and equitably apportion a previously determined number of manpower resources among existing MICOM PMOs. The model uses workload assessment, or surrogates for workload assessment, as the common denominator for comparison. With development of a high-fidelity historical data base, the MPM^3 will evolve into the desired deterministic model. Development of an appropriate data base and continued experience will also facilitate fine tuning of the heuristics in the model.

The model is used only as a guide by the MICOM Resource Committee.[3] Other traditional techniques such as manpower survey data, expert opinion, extrapolation of current work-force distribution, individual justifications of merit, and accepted analytical methods are also still in use. Of the total array of techniques in use, however, the MPM^3 is the only truly objective and quantitative tool available. This article describes the MPM^3, its capabilities, and its limitations.

Model Design Considerations

In a broad sense, the determination of manpower requirements and of future manpower needs for a PMO requires: (1) The analysis of the workload that will be involved in the endeavor under consideration, and (2) the application of informed judgment as to how many people must be employed to effectively deal with it. Quantitative data are derived from what is done: the mission, how it is done; the method or procedure, and when it is done; and the frequency. The raw data are then conditioned by a number of environmental considerations such as program scope, program complexity, program priority, the amount and level of higher authority interest, public interest and visibility, and similar factors. In formal project management there is also a core or minimum staff required. Temporary organizations staffed at levels below the core level represent some other form of intensive management.[4]

3. The MICOM Resource Committee is chaired by the Commander, MICOM, and is his manpower allocation apparatus. The committee establishes command manpower policies and monitors military and civilian strength to ensure maximum utilization within directed ceilings.

4. An authoritative description of manpower requirements determination may be found in Richard J. Niehaus, *Computer-Assisted Human Resources Planning* (New York: John Wiley & Sons, 1979), pp. 46-51.

The MPM[3] was designed to consider all of the factors discussed in the preceding paragraph. The conceptual premise of the model is that the management job to be done by all MICOM PMOs is fundamentally the same. Fine tuning of manpower requirements and manpower adjustments among the PMOs results from application of the environmental considerations cited earlier.

The model was designed to assess those discrete elements that most accurately describe the workload in a PMO. Concomitantly, these same elements also most accurately differentiate workload differences among PMOs on a comparative basis. As a result, the elements selected serve both the present needs of the apportionment application of the model and also will form the basis for the long-term deterministic application.

Please note that the model was not designed to measure every possible consideration of project management. It is, in effect, insensitive to qualitative factors affecting aggregate productivity and effectiveness of PMOs. As an example, the management and technical experience and competence of the PM, deputy, and staff are not measured. Such factors as individual employee morale, productivity, and stability are similarly excluded as are the amount and quality of external support provided by the functional adjuvant in the matrix organization and/or by contract. While these factors do affect the productivity and responsiveness of a PMO, they are typically assumed to average out as essentially constant among the PMOs and are accepted as "givens" that are currently unquantifiable.

Measurement Categories

The model measures workload under seven main headings that are subdivided into a total of 47 discrete factors. Many of the 47 factors will be recognized instantly as direct measures of workload, while the relevance of other factors to workload may be less direct. In the latter case the factors are surrogates, or proxies, for workload factors that have been validated through experience.

The five factors in the magnitude of business category are depicted in Figure 1. [Figures begin on page 14.] This category is aimed at measuring project scope in terms of its dollar volume for current, budget, and out-year programs.

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5. RSI stands for rationalization, standardization, and interoperability. For an excellent description of this DOD program to increase the effectiveness of the NATO Alliance see Ralph W. Patterson, Jr., "Rationalization Standardization and Interoperability: Tactical, Economic, and Political Considerations," *Program Managers Newsletter:* (March-April 1979), pp. 10-12.

The contract activity and its factors are depicted in Figure 2. The principal issue in this category is the workload associated with contract management and related activities and interaction with the purchasing element. The contractor integration factor addresses the issue of how system integration is accomplished for the project when there is more than one prime contractor or no prime contractor.

Figure 3 depicts the 16 factors associated with management complexity. This category is by far the largest of the seven in terms of the number of factors involved. The thrust of this category is measurement of programmatic issues that equate to management workload for the PMO. It covers a wide range of issues from interfaces with other agencies to RSE[5] to examination of the life-cycle status of the project.

System complexity is the fourth category in the model. The objective of this category is to assess the technical complexity of the system in terms of its hardware and software components. Notice that the number of weeks to train a maintenance team factor is a proxy rather than a direct measure of technical workload. The eight factors of hardware complexity are depicted in Figure 4.

Foreign military sales (FMS) activity is the thrust of the fifth category which is depicted in Figure 5. These factors represent a mixture of dollar, programmatic, and technical concerns with case management substituted for contract management. (The intent of this category is to measure the workload that is a genuine addition to ongoing PMO workload as a result of FMS activity.)

Figure 6 depicts the six factors associated with system logistics concerns. The objective of this category is to measure the logistics support involvement of the PMO through various volumes of logistics activity.

The final category in the model is that of project priority. Only one factor is involved and it relates to the relative priority ranking of the projects at MICOM as determined by the commander. This feature of the model permits the commander to add the equivalent of bonus points to projects based on their relative importance. The feature may or may not be used in the model and it functions equally well with or without this input.

Scoring and Weighting Components

Each of the 47 factors has a predisposed base that regulates how the weighting and scoring is approached for that item. The first part of the predisposed base is the overall weight of the factor under consideration in relationship to all other factors in the model. Three classifications were derived as depicted in Figure 7.

The second part of the predisposed base is a judgment that the workload volume relationship is either linear or non-linear in nature. A linear workload volume relationship assumes that every increase in the unit of measurement requires a corresponding increase in manpower. A non-linear workload volume relationship assumes that every increase in the unit of measurement does not require a corresponding increase in manpower, but benefits from learning curves, economies of scale, or natural responses to an external factor such as the project life cycle. Most of the non-linear relationships are "front-end loaded" and their curves flatten out as workload volume increases as shown in Figure 8.

Data intervals for the units of measurement for the factors were established by individual examination of data profiles for all PMOs at MICOM. Histograms of the data were run on the computer with changes being made to the intervals to produce the best approximation of a normal distribution of the raw input data. This corresponds to the premise that the management job to be done is fundamentally the same among PMOs and that a PMO that is staffed unusually high or low should be significantly different from a normal PMO. The results of the approximately normal distribution histograms, for each of the 47 factors, were somewhat irregular in some cases, resulting in uneven data interval scales.

Each interval of each factor was assigned a score based on the results of the analysis of the predisposed base and data interval determinations. The scores assigned to each interval of each factor were consistent within each of the three levels of the predisposed base. In other words, a factor classified as "high-linear" in one category of the model has the same score range as a "high-linear" in another category of the model.

As an example of the scoring and weighting, refer to Figure 9. The two factors illustrated are in two different categories of the model, but both are "high-linear" factors. Notice that the scoring range is the same for both factors as mentioned earlier. Notice also the irregularity of the data interval scale for factor 31.

Figure 10 depicts a comparison of two "low-non-linear" factors. A comparison of the scoring range with Figure 9 reveals the smaller number of points available for the "low" factors depicted in Figure 10.

Figure 11 depicts a comparison of two "medium-non-linear" factors. Comparison of the scoring range with those in Figures 9 and 10 shows that it falls in between the two extremes as one would suspect. Figure 11 also demonstrates again the irregularity of the data interval scales.

Points earned by a given PMO are calculated by selecting the proper interval entry for each factor that corresponds to the raw data for that project. An example is provided in Figure 12. The raw data entries are assumed for purposes of example and the points are taken from the six factors depicted in Figures 9 through 11. The procedure demonstrated in Figure 12 is repeated for all 47 items for each PMO. Total scores are computed for each PMO by summing points earned.

Final computations are calculated as follows: Each PMO's total score is added to the other PMO total scores and an aggregate number of "total points" is produced in the model. A percentage of each PMO's portion of the total points is then calculated. This percentage of the PMOs' total points is then calculated against the total authorized manpower staffing for all the PMOs in the aggregate. This could be the current number of authorized manpower spaces in MICOM PMOs, or it could be a number imposed by the decision-maker—either greater or less than the current authorizations. The percentage of total points for a given PMO determines the percentage of total manpower resources to be apportioned to that PMO.

An example of the scoring and staffing calculations is depicted in Figure 13. The number of manpower spaces involved in the example is 300 total for the three projects. Notice that the total does not change, but the number apportioned to each PMO would change as a result of the application of the model.

Interpretation of Results

The results shown in Figure 13 are the point recommendations of the model. Recognizing that the model is only a close approximation of the relative workloads among the PMOs analyzed, it is necessary to refine the point results. To compensate for the approximate nature of the model, a tolerance of ± 10 percent is added to the point recommendation. This results in an upper and lower limit for each PMO's proper staffing.

Figure 14 depicts the application of the tolerance limits to the point results displayed in Figure 13. Notice that Project "A" is overstaffed by 54 people while Project "C" is understaffed by 50 people. Project "B" falls within the upper limit and is considered in satisfactory condition. You should note that use of Project "A" spaces to offset the deficit in Project "B" could result in a net saving of four spaces.

The results depicted in Figure 14 also suggest where future manpower space "hits" should be made. As an example, if it becomes necessary to establish Project "D" within existing resources, Figure 14 suggests that up to an additional 12 spaces are available from Project "A" and up to 14 spaces are also available from

Project "B." Pulling spaces in this manner would achieve parity among existing projects by putting all three at the lower boundary. This is a far better solution than the across-the-board "hit" that typically occurs when manpower spaces must be taken "out of your hide."

Conclusions

The MPM^3 is operational at MICOM. It is not a panacea for *all PMO* manpower requirement problems, but it is a unique normative approach to manpower apportionment. It is used by analysts and decision-makers as an independent and unbiased input into the totality of quantitative and qualitative considerations that make up the manpower authorization determination process. The MPM^3 is an excellent synthetic aid to management in the apportionment of manpower resources. With time, experience, and refinement, the MPM^3 should evolve into an even more powerful tool with an added deterministic capability.

FIGURE 1
Magnitude of Business

- NUMBER OF DOD FISCAL APPROPRIATIONS
- AMOUNT OF APPROVED (FIVE YEAR DEFENSE PROGRAM/PROGRAM OBJECTIVE MEMORANDUM) PROGRAM
- CURRENT AND BUDGET YEAR APPROVED PROGRAM
- HIGHER AUTHORITY RECOGNIZED UNFUNDED PROGRAM REQUIREMENTS
- NUMBER OF FUNDED COMMANDS, LABS, AND OTHER GOVERNMENT AGENCIES

FIGURE 2
Contracting Involvement

- NUMBER OF SYSTEM/SUBSYSTEM CONTRACTORS
- NUMBER OF SYSTEM CONTRACTS WITH DELIVERIES REMAINING
- NUMBER OF SYSTEM BREAKOUT ITEMS
- NUMBER OF SYSTEM GOVERNMENT FURNISHED EQUIPMENT ITEMS
- NUMBER OF ACTIVE CONTRACT MODIFICATIONS FOR ACTIVE SYSTEM CONTRACTS
- CONTRACTOR INTEGRATION

FIGURE 3
Complexity of Management

- NUMBER OF ARMY ELEMENTS REQUIRING COORDINATION ONLY
- NUMBER OF ARMY ELEMENTS REQUIRING EXCHANGE OF FUNDS
- NUMBER OF OTHER GOVERNMENT AGENCIES (NON-ARMY) REQUIRING COORDINATION ONLY
- NUMBER OF OTHER GOVERNMENT AGENCIES (NON-ARMY) REQUIRING EXCHANGE OF FUNDS
- NUMBER OF COUNTRIES HAVING RSI MEMORANDA OF UNDERSTANDING/FORMAL NEGOTIATIONS
- NUMBER OF COUNTRIES HAVING CO-PRODUCTION/TECHNOLOGY TRANSFER PROGRAMS
- NUMBER OF HARDWARE/MANAGEMENT INTERFACES WITH OTHER SYSTEMS/SUBSYSTEMS
- NUMBER OF SYSTEMS MANAGED
- NUMBER OF APPROVED PRODUCT IMPROVEMENTS PROGRAMS (PIPS)
- HIGHEST LEVEL OF SYSTEM TECHNOLOGY
- AGE OF SYSTEM(S) SINCE IOC
- NUMBER OF THEATERS OF OPERATION
- NUMBER OF FORMAL SCHEDULED SYSTEM REVIEWS BY HIGHER AUTHORITY
- CURRENT FIELDING (IOC) OF SYSTEMS AND PIPS
- NUMBER OF CLASS 1 ENGINEERING CHANGE PROPOSALS
- LIFE CYCLE INVOLVEMENT

FIGURE 4
System Complexity

- SYSTEM COMPUTER SOFTWARE INVOLVEMENT
- NUMBER OF LEVEL 3 (PRODUCTION) DRAWINGS IN TECHNICAL DATA PACKAGE
- NUMBER OF SYSTEM REPAIR PARTS (SEPARATE STOCK/PART NUMBERS)
- NUMBER OF WEEKS TO TRAIN A MAINTENANCE TEAM
- NUMBER OF MAJOR SYSTEMS/SUBSYSTEMS
- NUMBER OF GROUND SUPPORT EQUIPMENT ITEMS
- MAJOR/NON-MAJOR SYSTEM CATEGORY
- NUMBER OF RSI (COUNTRY INTERCHANGEABLE) ITEMS

FIGURE 5
FMS Involvement

- APPROVED FMS PROGRAM
- NUMBER OF FIRM, SCHEDULED FMS REVIEWS (HIGHER AUTHORITY OR COUNTRIES)
- NUMBER OF DIFFERENT GENERIC FMS SYSTEMS (FROM US CONFIGURATIONS)
- NUMBER OF FIRM, SCHEDULED FMS REVIEWS (HIGHER AUTHORITY OR COUNTRIES)
- NUMBER OF DIFFERENT GENERIC FMS SYSTEMS (FROM US CONFIGURATIONS)

FIGURE 6
Logistics Involvement

- NUMBER OF EQUIPMENT IMPROVEMENT REPORTS RESULTING IN SYSTEM CHANGES (EIR CASES)
- NUMBER OF TECHNICAL MAINTENANCE MANUAL PAGE CHANGES
- NUMBER OF NON-OPERATIONALLY READY, SUPPLY (NORS) NOTICES
- SPECIAL SUPPLY SYSTEM(S) INVOLVEMENT
- NUMBER OF DIFFERENT COMMAND AMP'S/PAA INTERCHANGE STUDIES
- NUMBER OF LOGISTICS SUPPORT ANALYSIS ITEMS (OR PROJECTED IN ILS PLAN)

FIGURE 7
Predisposed Weighted Base

- HIGH–FACTOR VERY IMPORTANT TO A PMO AND ITS STAFFING CONSIDERATIONS
- MEDIUM–FACTOR IS OF AVERAGE IMPORTANCE TO A PMO AND ITS STAFFING CONSIDERATIONS
- LOW–FACTOR IS OF MINIMAL IMPORTANCE TO A PMO AND ITS STAFFING CONSIDERATIONS

FIGURE 8
Non-Linear Workload Volume/Manpower Relationship

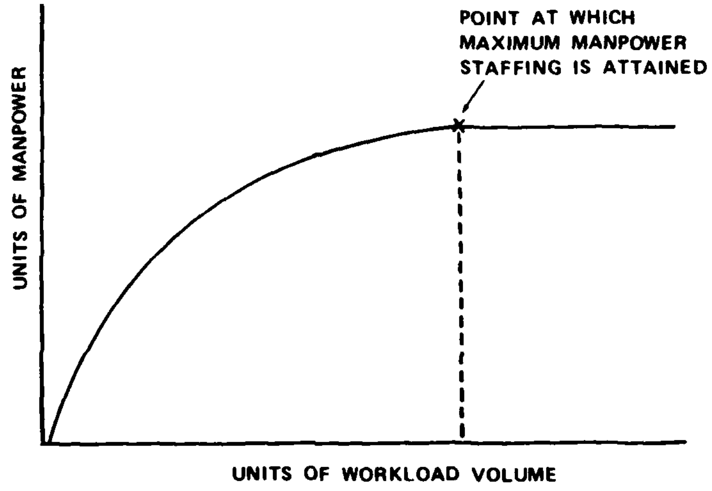

FIGURE 9
Comparison of Two High-Linear Factors

FACTOR 1. NUMBER OF DOD FISCAL APPROPRIATIONS
WEIGHT: HIGH
WORKLOAD RELATIONSHIP: LINEAR

INTERVALS (NUMBER OF APPROPRIATIONS)	SCORING (POINTS)
1-2	20
3	30
4	40
5	50
6 OR MORE	60

FACTOR 31. NUMBER OF WEEKS TO TRAIN A MAINTENANCE TEAM
WEIGHT: HIGH
WORKLOAD RELATIONSHIP: LINEAR

INTERVALS (NUMBER OF WEEKS)	SCORING (POINTS)
1-3	20
4-16	30
17-35	40
36-52	50
OVER 52	60

FIGURE 10
Comparison of Two Low-Non-Linear Factors

FACTOR 4. AMOUNT OF HIGHER AUTHORITY RECOGNIZED UNFUNDED REQUIREMENTS

WEIGHT: LOW
WORKLOAD RELATIONSHIP: NON-LINEAR

INTERVALS (DOLLARS)	SCORING (POINTS)
1-50M	5
51-200M	9
201-600M	12
601-1,000M	14
OVER 1,000M	15

FACTOR 30. NUMBER OF SYSTEM REPAIR PARTS

WEIGHT: LOW
WORKLOAD RELATIONSHIP: NON-LINEAR

INTERVALS (NUMBER OF PARTS)	SCORING (POINTS)
1-500	5
501-2000	9
2001-10,000	12
10,000-20,000	14
OVER 20,000	15

FIGURE 11
Comparison of Two Medium-Non-Linear Factors

FACTOR 2. AMOUNT OF 5 YEAR APPROVED PROGRAM (FYDP/POMM)

WEIGHT: MEDIUM
WORKLOAD RELATIONSHIP: NON-LINEAR

INTERVALS (DOLLARS)	SCORING (POINTS)
0-150M	10
151-300M	18
301-1,000M	24
1,000-2,000M	28
OVER 2,000M	30

FACTOR 7. NUMBER OF ACTIVE SYSTEM CONTRACTS MANAGED WITH DELIVERIES REMAINING

WEIGHT: MEDIUM
WORKLOAD RELATIONSHIP: NON-LINEAR

INTERVALS (NUMBER OF CONTRACTS)	SCORING (POINTS)
1-5	10
6-15	18
16-35	24
36-150	28
OVER 150	30

FIGURE 12
Example of Points Calculation

FACTOR NUMBER	RAW DATA	POINTS
1	5 APPROPRIATIONS	50
2	$ 777M	24
4	$ 52M	9
7	17 CONTRACTS	24
30	1550	9
31	28	40
↓	↓	↓
47		
		TOTAL

FIGURE 13
Three PMO Examples

- SCORING CALCULATION

PMO/SYSTEM	TOTAL SCORE	% OF TOTAL SCORE	AUTHORIZED MANPOWER STAFFING
A	500 PTS	20%	120
B	800 PTS	32%	100
C	1200 PTS	48%	80
TOTALS	2500 PTS	100%	300

- MANPOWER CALCULATIONS

PMO/SYSTEM	% OF TOTAL SCORE	TOTAL PMO AUTHORIZED STAFFING	MODEL RECOMMENDED STAFFING
A	20%	300	60
B	32%	300	96
C	48%	300	144

FIGURE 14
Summary Results

PMO	UNDER	-10% OF MODEL POINT	MODEL POINT		+10% OF MODEL POINT	OVER
A		54	60		66	$\boxed{120}$
B		86	96	$\boxed{100}$	106	
C	$\boxed{80}$	130	144		158	

AUTHORIZED STRENGTH

MODEL RECOMMENDATION

Fielding Army Systems: Experiences and Lessons Learned

20

Colonel James B. Lincoln, USA

For the past decade, the Army has been spending about $2 billion dollars a year on resource and development. Until recently this huge investment has resulted in little payoff in modernizing the Army. In the face of the stark realization that we are inferior, equipment-wise, to our potential enemies, the long overdue equipment modernization has finally begun. In a recent joint statement to the Congress, the Army's senior civilian and military heads of research, development, and acquisition summed up the situation:

> At this point, the U.S. Army is . . . from an equipment point of view . . . second rate. . . . But we have within a period of three to four years, the opportunity to transform [the Army] into one that is competitive with the Armies of our potential enemies.[1]

But the modernization process is far more significant than a 5-year changeover in equipment at the cost of some $30 billion. Dynamic changes in the enemy threat, in technology, and our national strategy lead to development and fielding of new systems with accompanying changes in tactics, doctrine, training, and support concepts. Systems are now developed as part of an integrated battlefield concept, so that changes or delay in any one system can cause a chain reaction of adverse impacts. The challenge we face was highlighted and measured by the Army's Chief of Staff, General Edward C. Meyer, when he said ". . . it will be a tremendous problem to bring in all this equipment—the greatest problem, in my view, that the Army has ever faced."[2]

After the affordability question is resolved, a major issue remains—the challenge of accomplishing an efficient fielding of each new system without a major disruption of our field units. After years of development and testing and the expenditure of millions of dollars to prepare the system for fielding, the proc-

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1. Lieutenant General Donald Keith, The Honorable Percy Pierre, Joint Statement before House Armed Services Committee, 23 February 1979.
2. Address before the National Security Industrial Association, Washington, D.C., 16 November 1979.

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ess of handing over the new equipment to the unit to be equipped would seem rather straightforward. But from the perspective of the receiving unit and its tactical and logistical supporters, the process can be very complex, burdensome, and costly, if not managed properly. The changeover can also temporarily degrade readiness, despite the introduction of a new weapon system with increased capability. Clearly, the introduction process is of basic importance if the Army wants to ensure early improvement in capabilities, as opposed to possible temporary deterioration.

The Bow-Wave Problem

As a ship increases speed, a wave of water builds up at the bow, limiting the speed of the ship. The Army has its own "bow wave" in the form of a build-up of new systems, all in the fight for limited resources. The double impact of continuing Vietnam expenses and mounting costs arising from complexity and inflation delayed the development of many systems. The effect of Vietnam carried over to the early 1970s, as the Army was able to field only the most needed systems, such as LANCE, Vulcan/Chaparral, Dragon, and TOW. The Army also experienced technical problems while developing several badly needed systems such as the new main battle tank, an Infantry combat vehicle, and a new armed attack helicopter. After being canceled, these three systems were redefined and started again, thus causing "ripples" that added to the present-day bow wave of more than 40 major systems and several hundred smaller systems scheduled for fielding in the next 5 years.

We have already experienced the first year of the bow wave, as 1979 saw the fielding of several new systems. These included TACFIRE, M198 Howitzer, Black Hawk helicopter, and TSQ-73 Missile Minder. Other systems, also fielded in 1979, that provided major new capabilities, but were "product improvements" of an existing system, included the M60A3 tank and Improved TOW Vehicle (ITV), M901. By 1979, the up-gunned and modernized Cobra helicopter, the AH-1S, had been fielded in both Europe and CONUS.

Although the Army acknowledges that it cannot afford all of the systems scheduled for fielding, it has apparently rejected terminating lower-priority programs and increasing the buys of higher priority ones. The Army has also informed Congress that it must fund and field all planned systems for two major reasons. First, the systems represent an interdependent combined arms team, all of which are essential to achieve the necessary combat power on the battlefield. Second, the defense industrial base must be equipped and refurbished to a capacity level that could be rapidly expanded in case of war. These points, and the critical question of how multiple fieldings can be afforded, were addressed in the Army's most recent statement to the House Armed Services Committee on February 26, 1980:

> If we are to buy all the systems we are requesting today, and stay within the resources we can reasonably expect to be available to us over the next five years, we will have to buy some systems at less than the *Optimal* economic rate. . . . What we propose to do is to buy the highest priority systems at the highest rate we can, and the lower priority systems at the minimum economic rate.[3]

Importance of Fielding Process

However strong and dramatic the efforts in the crucial areas of design tradeoffs, training, and logistic support, the entire spectrum of impacts will focus on the fielding process. The importance of the process and our own recent experiences make the process of fielding systems worthy of review and analysis for several reasons. First, the recent systems experienced varying degrees of success when fielded. The Army was reminded that the fielding process is far more than a simple hand-off of the new equipment to the gaining command and first unit. Second most of the complex procedures and regulations related to the fielding process were first applied with these systems. Finally, a large number of systems will be fielded in the next 5 years, indicating that a definitive assessment of the process, based on the experiences of the 1970s, should be accomplished.

While the development and production phases of the weapon acquisition process have been studied and restudied, resulting in countless procedures, regulations, and guidelines to assist the acquisition manager at every step, the fielding process itself has not been studied. There are few lessons learned from studies or follow-up reports on recent fieldings that could be used to prevent a repetition of problems. It was not until 1976 that a user "hand-off" concept was implemented with the fielding of the M-60A2 tank in Europe. Specific materiel fielding guidelines were established in 1977, but only as part of the overall subject of integrated logistics support (ILS).[4] In early 1980, DARCOM published a pamphlet on materiel fielding,[5] but its scope is limited to DARCOM activities and is by no means a comprehensive guide to the total process.

Methodology

This paper cannot be considered a comprehensive and definitive assessment of the materiel fielding process. However, as an initial catalog of problems ex-

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3. Lieutenant General Donald Keith, The Honorable Percy Pierre, Joint Statement before House Armed Services Committee, 26 February 1980.
4. DARCOM Sup 1 (20 June 77) to AR 700-127, 11 April 1975, Integrated Logistics Support.
5. DARCOM Pamphlet 700-9-4, Instructions for Materiel Fielding, 1 March 1980 (draft).

perienced and analysis with lessons learned, it is written primarily to stimulate follow-on studies and specific corrective actions. The research effort was most challenging because there are few systems that have provided any after-action reports or lessons learned on the fielding experience. Project offices retain very little information on past activities. The task was at times haphazard because of the absence of any overall established system or procedure that would have ensured the recording and documenting of the type of information needed.

Information for the paper was collected through numerous letters, phone calls, and interviews. References on the fielded systems included materiel fielding plans, test reports from the Operational Test and Evaluation Agency (OTEA), new materiel release files on each system, and data from the Army modernization information memorandum (AMIM). Other data were obtained from project memos, reports, and replies to letters sent by the author to project offices, TRADOC system managers (TSM), commanders of IOC units, and force modernization offices.

Basic Concepts

Contributing to the difficulties experienced during the planning for fielding is the lack of understanding of the key activities and terms related to the fielding process. The least understood concept is the most critical event in the life cycle of the system—IOC.

Initial operating capability (IOC) is the culmination of the development and initial production process, and is defined as follows (DA PAM 700-127):

a. First unit equipped with required quantities of production items
b. Unit personnel adequately trained to operate, care for, maintain and support the item in the field
c. Materiel fielding plan distributed and materiel fielding team deployed
d. At or above 90% fill of both range and quantity of repair parts, special tools, test measurement diagnostic equipment (TMDE), and calibration equipment
e. Technical publications on hand, final MOS decision announced, TOE approved by HQDA, new equipment training completed, training aids and devices issued, and soldiers' manuals and ARTEP approved and issued.

The key events essential to achievement of the initial operational capability include:

Manufacturing (production) of required end items, repair parts, and other initial support items necessary for initial and sustained operation of the complete system in field units.

Materiel testing of production items, to include development/engineering tests, and some form of operational test, such as operational test III (OTIII), follow-on evaluation (FOE), or force development test experimentation (FDTE). Operational tests are usually conducted by the Operational Test and Evaluation Agency, while development tests are normally conducted by the Test and Evaluation Command (TECOM).

Release of materiel for issue (DARCOM Regulation 700-34) requires that new systems receive a release certification to ensure suitability for troop use in terms of quality, safety, performance, reliability, and supportability. The Commander, Test and Evaluation Command, is required to provide a "suitability for issue" statement as part of the release action. This statement is based on adequacy of material performance during test conducted by TECOM. (The actual readiness of field units and the receiving command to operate and maintain the equipment is not directly considered in this release, and is not the responsibility of DARCOM.)

ACHIEVING IOC

A successful IOC requires far more than accomplishing these basic activities. The acquisition community must accomplish a wide range of activities over a period of years that require careful coordination and the cooperation of numerous agencies. A "critical path" exists, though not always clearly known or charted. If any one critical path event is delayed, an on-time IOC will not be possible.

IOC dates are often established as "best estimate" projections of the earliest possible date that initial fielding can be accomplished, and the program manager is faced with the difficult task of executing a highly optimistic and success-oriented schedule that has little or no margin for delay or "unknown-unknowns."

Difficulties associated with the "rush" to achieve IOC bring about some of the lessons learned, to be discussed in this paper. The process can be characterized as the antithesis of Parkinson's Law. Instead of work expanding to fill the time allotted for its execution, too much work must be compressed into too little time in order to meet an inflexible completion date. An important lesson learned stems from this "time-squeeze" situation. After establishing a fielding date that is little more than a highly optimistic projection, the PM feels compelled to achieve that date, despite the problems and shortcomings that may exist when that "magic" date arrives. Furthermore, the date is advertised to OSD, Congress, and, of course, the user. Non-achievement of the date is tantamount to failure. But the price of success in these cases can be fielding of a system that is not ready to be placed in the hands of the first unit. This is not to say that flexible IOC dates are the answer. Such an approach would have a tendency to result in delaying IOC to the latest possible date, because of the effect of removing a hard deadline. The

basic concept of IOC, summarized and briefly discussed in this article, needs a comprehensive review all its own.

TRADOC SYSTEM MANAGERS

A new concept that has significant impact on the fielding process is the TRADOC system manager (TSM) concept. The TSM is the counterpart of the project manager on the user side. He works for the Commanding General, TRADOC, through the appropriate school/center commander, and is responsible for personnel, training, employment concept, and user-oriented logistic requirements of the new system. He is the focal point representing the user, and works with the PM in a complementary fashion on all aspects of development, testing, and fielding.

PAST EXPERIENCES

Before considering the more recently fielded systems, it is worthwhile to consider systems fielded in years past. Examples were selected for two reasons. First, some limited documentation was available for the systems selected, and second, the systems to be discussed present valuable lessons. Many of the lessons cannot be classified as lessons learned because a repetition of problems continues to occur.

Sheridan/Shillelagh Weapon System

In the early 1960s, the Army embarked on a three-part tank development program that utilized a radical new concept of a guided, low-velocity, 152mm projectile, with a combustible cartridge case. The program included the M551 Sheridan vehicle, a modified M60A1 tank, and the MBT-70 German-American tank program. The concept was based on commonality of ammunition (with the obvious benefits) and a tank killing capability that would "meet the threat" of the 1970s.

The Sheridan design represented a radical change from armored vehicles of the past. Besides firing the guided projectile, the vehicle would be lightweight, swimmable, and airdroppable, and would achieve greatly improved mobility. From the start, development of the system encountered major problems, particularly with the ammunition. The vehicle was approved for production, despite numerous technical problems and incomplete test results. In 1969, the M551 was deployed to Vietnam to meet an "urgent" field requirement. By 1970, 1,660 vehicles had been produced, the program had cost over $1 billion, and most of the vehicles were in storage awaiting modifications to make them acceptable for fielding.

The vehicle was modified by 1975 and became the M551A1 with the addition of a laser range finder. Also in 1975, a major product improvement program

(PIP) was initiated in order to eliminate the numerous technical and maintenance problems that had plagued the vehicle since fielding. But in 1978, the Army decided to withdraw the vehicle from the active inventory,[6] with a plan to use some 330 vehicles as non-firing training tanks at the new National Training Center.

Although the remaining 1,110 vehicles are being considered for a possible role in the Rapid Deployment Force, the Army paid a very high price for a short-lived, trouble-plagued combat vehicle that was of questionable operational value.

Both the development and fielding of the Sheridan provided many useful lessons learned. The Army staff began pressing the U.S. Army, Vietnam, to accept the Sheridan as early as 1966, despite the lack of main gun ammunition. The vehicle was finally fielded in 1969, without its anti-tank missile system.

Different approaches were used by the two units in Vietnam to transition to the new weapon. The 11th Armored Cavalry Regiment elected to stand down units for seven uninterrupted days for transition training. The 3d Squadron, 4th Cavalry, decided not to stand down during the transition. Despite the temporary loss of combat power, the stand-down approach proved to be highly effective.[7]

As the vehicle began its combat role, it suffered numerous problems. Many of the troops in Vietnam assigned to M551 units considered the vehicle extremely hazardous. Ammunition fires, rounds that went off prematurely, and numerous maintenance problems gave the vehicle a poor reputation. Troops rode on top of the vehicle rather than inside because of the danger of mines and ammunition fires. Although the PM and other program personnel visited Vietnam to try to stay abreast of the situation, the vehicle continued to have problems. In 1970, the commander of the 11th Armored Cavalry Regiment wrote the following to the Commanding General, U.S. Army Vietnam:

> *Lack of Appreciation for the combat environment:* When the Sheridan performs a given mission in an outstanding manner at Aberdeen Proving Ground, this does not mean that it will even meet minimal standards in the jungles of Vietnam. . . . As CINCUSARPAC stated in his farewell visit to the Regiment on 21 September, the Sheridan was designed to swim, to be airborne, and to achieve a first round hit at great range against enemy armor, but is used for none of these purposes in Vietnam.
>
> *Overly-defensive attitude:* TECOM and the project managers are

6. One battalion (54 vehicles) is being temporarily retained in the 82d Airborne Division. Other war reserve vehicles are also being retained.

7. General Donn A. Starry, *Mounted Combat in Vietnam*, DA Vietnam series, 1978, pp. 142-144.

> understandably concerned about the failure of the Sheridan to live up to expectations. Instead of admitting that the Sheridan needs improvements to make it an effective combat vehicle in jungle operations, the tendency is for CONUS managers to blame shortcomings on poor quality of maintenance in the field, the failure to follow instructions in the TM's that apply to range rather than combat firing, and to make the vehicle do what it is not designed to do.[8]

Perhaps the Sheridan was doomed from the beginning of its development, because its engineers expected to solve problems that were on the outer fringes of the state of the art. Its fielding in an environment for which it was not intended, and one where the receiving command actively campaigned against its issue, will hopefully remain unique in Army fielding history. In any case, the problems and their impact were part of the reason the Army decided to institute the "hand-off" concept, which was first used on the M60A2 tank.

M60A2 Tank

The old reliable M60A1 tank was to be modified to fire the 152mm Shillelagh as part of the new tank concept. The plan was to mount the new weapon system on the M60 hull with a modified turret gun stabilization and fire control system. All M60s would become 152mm tanks to provide an interim Shillelagh capability until the MBT-70 was fielded. But, as the *Armed Forces Journal* said:

> Between the idea and delivery, however, something went wrong with the M60A1E2's gun stab and fire control systems which Chrysler is still trying to fix. The problem became a major scandal in congressional hearings and in October '68 the FY 70 buy was cancelled. Initial deliveries began in April 68, were completed in December of that year and consisted of 243 turrets to be retrofitted to existing M60A1 hulls and 300 complete M60A1E2 tanks.[9]

The Army suspended the program and began a major redesign and rework program, followed by a series of engineering and service tests. The results were a new set of deficiencies with some improvement in the mean miles between failure from the previous 30 to about 100. A controversial decision in October 1974 approved the tank for production, despite the user's (CONARC) assessment that the tank was "not battleworthy," and the CDC position that the program should

8. Letter, HQ, 11th Armed Cavalry Regt., Subject: M551 Sheridan Lessons Learned During Maintenance, 8 October 1970.
9. *Armed Forces Journal*, 5 October 1970, p. 27.

be terminated.[10] Production deliveries began in 1974, and 54 tanks were subjected to an operational test at Fort Hood, Texas. Numerous vehicle and supportability deficiencies resulted. The Army Systems Acquisition Review Council (ASARC) decided to permit fielding of the vehicle, but directed the PM to accomplish a refurbishment program, and provide a complete support package upon fielding in Europe. The unit at Fort Hood retained the test tanks to become the first unit equipped with the M60A2, but the real fielding was to begin in Europe in 1976.

DARCOM used the M60A2 to implement a new "hand-off" procedure that provided a "warranty" and "total commitment to the user" and his needs at fielding. At a DARCOM conference in May 1976, the Deputy Commanding General of DARCOM reported that ". . . the concept has proven its worth. The results have been tremendously gratifying and have confirmed that the Project Handoff is the path we must pursue."[11]

But there are always different perspectives on what constitutes success. The commander of that first M60A2 unit in Europe had this to say about the "hand-off":

> The Hand-off of the M60A2 had some good points and bad points. The supply system in-country was virtually nonexistent in the beginning. We used up our "push" packages before we returned from the transition training. We also had shortages in BII, and just about no test equipment was issued with the tanks. The fire control had a very high failure rate and there were few replacement components. USAREUR had to set up a rebuild capability in country to get us well. Our readiness rating suffered, but would have been much worse without the intense management from above since we were the hottest thing in Europe.[12]

An explanation for some of the problems is contained in a 1976 Lesson Learned After Action report from DA, DCSLOG:

> Apparently part of the provisioning package for the IOC battalion was lost in the depot and insufficient parts were available at the unit's home base upon return from transition training at

10. Major David V. Swanson, "Lessons Learned, Logistics Support-M60A2 Tank, ODCSLOG (undated but reconstructed as of October 1976).

11. Lieutenant General E. J. D'Ambrosio, "Readiness—Rhetoric or Reality?" *Acquisition Guidelines*, DARCOM PAM 310-1-5, August 1976.

12. Colonel Frank K. Rutherford, then Commander, 1st BN, 32d Armor, interviewed at the Industrial College of the Armed Forces, January 1980.

> Vilseck. It is estimated that 40% of the M60A2 tank fleet in that unit would have been down if it had not been for the extraordinary efforts of the Project Manager.[13]

The same report discussed problems that occurred with the turret and scavenging systems, and shortages of trained turret mechanics. Identical problems had occurred years earlier (and were still occurring) with the M551 system. The report's overall assessment included the following:

—The DA-directed requirement that tanks be refurbished and a complete support package be prepositioned prior to deployment was not accomplished;

—There was a lack of formal agreement on support responsibilities and inadequate planning by USAREUR;

—Deficiencies that had been discovered in prior testing had not been corrected on fielded vehicles;

—Inadequate quantities of repair parts were available, and the experience factors gained during the operational test were not properly used to determine items and quantities;

—USAREUR would not permit requisitioning parts in excess of original authorizations (i.e., off-line parts control).

The M60A2 fielding experience also provided a potential lesson learned about over-reliance on contractor support. Both at Fort Hood and in Europe, contractor personnel played a major role in repairing components, managing component replacement actions, and accomplishing much of the critical maintenance. When these personnel finally departed, there was major impact on the unit. Also, during the Fort Hood test and the transition firing activities, parts were replaced with little or no accountability with regard to "demand data." Valuable parts experience was lost. (Demand data is the "heart and soul" of the parts supply system; thus readiness was undoubtedly affected for many months to come.)

It is perhaps ironic that as the M60A3 is being fielded, the M60A2 seems headed for the same fate as the M551, with even fewer years in the inventory. The Army can be thankful there are only 540 in the inventory.

Chaparral/Vulcan

The Army deployed the Chaparral/Vulcan air defense system in 1969-70 to meet another "urgent" requirement in Europe. The system was deployed without its Forward Area Alerting Radar System (FAAR), which had suffered major

13. Major David Swanson, DCSLOG After Action Report.

technical difficulties, resulting in production termination in July 1969. The system offered limited capability to begin with, but without the radar the system achieved only a marginal improvement in capability.[14] It was not until 1978 that the FAAR radar was fully deployed with the system.[15] By that time, numerous reliability improvements had been applied to the system, but even to this day the system has a poor reputation with both field units and the logisticians who support it.

I mention the system because it can again provide an important lesson learned about the value of properly preparing the field units for the arrival of a new system. (The lesson also applied to the M551 experience.) The specific design of the system was in response to a series of threat analysis and requirement studies in the air defense area. The system was designed as a good weather, daytime-only system, and although there were unexpected reliability and maintainability problems, its limited capability was part of the intended design. Field units apparently expected a system that could do much more, but were not properly prepared by the developer for the real capabilities of the system. An important part of the job at fielding for the PM and TSM is to prepare the user for the new system by making sure the user knows exactly what the system can and cannot do.

Field Artillery Digital Automatic Computer

The fielding of the field artillery digital automatic computer (FADAC) in Vietnam was another example of failure to prepare the user and ensure that he understood what the piece of equipment could do and how to use it. Many artillery commanders who lacked experience with computers would not use FADAC because they totally lacked confidence in the "machine" that would determine where the bullets would go.

The problems of these early systems should not be oversimplified by saying that the Army made a poor decision in deploying them. Each system provided a new and improved capability that was temporarily or partially negated by problems that existed at fielding. The technical problems and logistical support difficulties would unfortunately become serious problems for the user, whose situation was not adequately considered by the developer in these earlier years. With the introduction of Project Hand-Off and the progress of the ILS program from lip service to at least partial reality, fieldings were expected to be better for the user. Fortunately, the marriage of the developer with the trainer/user in the development state was to become a practical reality.

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14. "Acquisition of Major Weapon Systems," *GAO Report to Congress*, 18 March 1971.
15. A limited number of FAARs were delivered in 1972.

In the next section, I will discuss lessons learned from the fieldings of the more recent systems.

LESSONS LEARNED: SYSTEMS FIELDED IN 1979

The systems fielded in 1979 that were used to formulate lessons learned included:

—Tactical Fire Direction System (TACFIRE)
—M-198 155mm Towed Howitzer
—M-60A3 Tank
—Black Hawk Helicopter, UH-60A
—Improved TOW Vehicle, M-901
—TSQ-73 Missile Minder
—AH-1S Cobra Helicopter (fielded in 1977-78)

Rather than discuss lessons learned for each system, it will be more beneficial to categorize the lessons learned into functional areas. Some lessons learned are based on the experience of several systems, while others are based on the experience of a single system. The categories are as follows:

—Selected ILS activities
—New materiel release requirement
—Operational testing
—TRADOC system managers
—Impact of fielding on the command unit
—Contractor maintenance support

The primary guide used by program offices during the fielding of these systems was DARCOM Supplement 1 to AR 700-127. The supplement also contains a format for the Materiel Fielding Plan. A new regulation, DARCOM Regulation 700-15, was recently published to replace the supplement. Although a significant improvement, the new regulation could be further improved by incorporating changes derived from the lessons learned discussed in this section.

Selected Integrated Logistics Support Activities

ILS has increased in importance in recent years and it is now clear that logistics matters are too closely integrated with personnel, training, and the operational concept to be left solely to the logisticians. Inadequate logistics planning is often the cause of program delays and cost growth and has the potential to cause more problems at fielding than any other activity.

Lead time for ILS activities has grown tremendously in recent years. Initial provisioning, the process of determining and acquiring the range and quantity of support items necessary to operate and maintain an end item of material for an

initial period of service, is a large part of the ILS process. Early thorough planning, coordination, and monitorship throughout the acquisition process is necessary to its success. Even so, the formal part of the process which starts after the production decision often exceeds 24 months. Procurement lead time for both repair parts and for acquisition and delivery of provisioning technical data are the biggest consumers of time in this prolonged process. Development of technical manuals has become increasingly complex because of the current Army environment. Personnel turbulence, equipment complexity, skill drain, and the low educational level of the current soldier make it mandatory to develop manuals that will be usable and help to overcome these problems. Today this means making greater use of illustrations and writing to a specific target audience. This does extend development time for technical manuals. Facilities or construction requirements need to be provided to the gaining command at least 5 years in advance of fielding. The issue of "who pays" for initial support items (repair parts, tools, test equipment, etc.), be it DARCOM or the receiving major command, has become so critical that it was recently the subject of an "8-Star" letter to the Army Chief of Staff, sent from the Commanders of both USAREUR and FORSCOM.[16]

Receiving commands are becoming so concerned about system logistics and "supportability" that they have even recommended a delayed IOC until "validation of the ILS package." A message from USAREUR to the Deputy Commander of DARCOM on the fielding of the M60A3 made these points:

> We want to insure the operational readiness of our units is not degraded. . . . Information available indicates that problems remain in the ILS package, specifically, inadequate TMs, insufficient special tools and test equipment, a shortage of repair parts . . . and incomplete programs to establish a depot maintenance capability in USAREUR. . . .
>
> These deficiencies indicate that the M60A3 could not be properly supported if fielding commenced on the programmed IOC date. . . . We have no alternative but to recommend strongly delaying the IOC battalion deployment by a minimum of 90 days.[17]

The deficiencies of the M60A3 ILS package were found to be typical of the recently fielded systems.

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16. The issue brought up in the letter was basically resolved by a confirmation of no change in the existing policy; i.e., gaining command must program and pay for most initial support items.
17. DTG231700Z February 79, Subject: M60A3 Deployment.

PROVISIONING

Availability of the proper range and quantity of repair parts at fielding is one of the most complex of all ILS requirements. Planning must account for not only system-peculiar parts, but also non-peculiar items, and those managed by other services and agencies such as the Defense Logistics Agency. Quite often, intensive management will be given to the system-peculiar parts while neglecting the "common" items, which often become a problem at fielding.

It is essential that the program office set up a tracking and audit trail system for all provisioning actions. From identification, procurement, cataloging, and NSN assignment to stockage in the unit and depot, intensive management is required to ensure proper availability at fielding. Another critical event from the user point of view is the formulation of the SLAC deck, which lists the items for initial stockage by the units. Because of the cost impact of initial provisioning on the gaining unit, the formulation of minimum essential SLAC items has become an area of great importance. The listing should be carefully studied by both the program office and the gaining unit prior to actual procurement and stockage of parts.

Various approaches to stockage of repair parts that utilize contractor management for an initial period are being tested. Contracts require packing of kits that contain not only contractor-supplied items, but other parts that are provided to the contractor for packing and shipping to the field unit. In another approach, the NICP is provided requisitions and instruction for direct shipment to a designated unit. These new approaches may provide the basis for major changes in initial stockage procedures.

Whether initial stockage is accomplished by pull, call forward, or some form of package shipment, the burden of ensuring that the initial units are properly stocked should be on the developer, not on the field unit. It also seems logical that DARCOM should fund for the initial support items, at least for the IOC unit. This question, however, is still under debate by DA, DARCOM, and the major commands.

TECHNICAL MANUALS

Within the past 3 to 4 years, revolutionary changes have occurred in the format and content of technical manuals. To cope with more complex systems and the intelligence level of the soldier, profusely illustrated manuals with more detailed explanations of all required actions have been developed. The concept of integrated technical documentation and training (ITDT) is being replaced by skill performance aids (SPAs). Concepts such as front-end analysis and reliability centered maintenance (RCM) are part of the new manuals, and the previously complex equipment serviceability criteria (ESC) system has been replaced by a

listing of maintenance checks in the operator manual, known as preventative maintenance checks and services (PMCS).

All of these features greatly improve the readability of the manual for the soldier, but they also result in a manual development process that is complicated and lengthy. With the numerous required reviews, tear-down checks, verifications, and validations it is unlikely that a system will be fielded with a final-version manual. An additional 3-4 months can be added for printing and "pin-point" distribution. Recent experience has shown that there are advantages to fielding with a draft version of the manuals, thus allowing for later changes from testing and validation exercises. The draft TMs can be printed and distributed directly to the field by the program office (in some cases, the equipment contractor prints the manuals). The SPA procedures permit fielding with a "final draft" manual, allowing 12 months to ". . . purify and update before publishing as DA authenticated manuals."[18]

The recently fielded systems demonstrated the importance and benefits of soldier validation of the draft manuals at several stages during the development process. But the acid test of manual development is the status of the manuals at fielding time, and the reaction of the first unit equipped. The materiel fielding team should ensure that manuals are issued for special tools/test equipment, transportability, and system ancillary items. Also, the manuals should contain up-to-date listings of basic issue items (BII), additional authorization list (AAL), and necessary expendables, with NSNs (not just part numbers).

If any system modifications that are not reflected in the manuals have been made, these changes should be pointed out to the unit along with any part or NSN errors. Strict control of any manual changes at the time of fielding is another essential action. IOC units have found themselves with so many different copies/editions of manuals that problems with operation and maintenance have resulted.

BII; SPECIAL TOOLS; TEST, MEASUREMENT, DIAGNOSTIC EQUIPMENT

As a new system proceeds through development and to the point where actual hardware appears, the system exists and functions in a mostly "sterile" environment that includes labs, engineering tests, and proving-ground-type tests under controlled conditions with "white-coat" GIs. It is likely that the system can function adequately in such environments with only limited use of any BII, special tools, or test equipment. The first operational test or use by "real" soldiers will

18. TAG Letter, Subject: Skill Performance Aids (SPAS) Program, 4 June 1979.

reveal shortcomings in the development of these items, and every such use thereafter will result in the need for more changes. A primary ILS goal should be to minimize the need for these items because of the major burden they place on the supply system and crew upkeep requirements.

Development decisions on the makeup of BII, special tools, and TMDE should be based, first, on a careful study of the functional and maintenance needs of the system and, second, on accurate analysis of existing and proposed common tools and test and diagnostic items. In some cases, erroneous assumptions are made about the availability of items that may be important to the operation and maintenance of the new system. An area often overlooked is expendable supply items. Not only should the PM accurately determine expendables necessary for use with the system, he should also ensure availability of these items at fielding time.

One of the PM's most important responsibilities, from the point of view of the fielded unit, is to plan and program the funds for system support items, and ensure their availability when the equipment is fielded. New equipment should arrive at the unit with complete BII, and a complete issue of special tools and TMDE. The PM and gaining major command should also agree on what additional special kits, tools, ancillary items, etc., will be provided, and who pays for them.

For an appreciation of the quantities of these items fielded with the most recent systems, Figure 1 reveals that the crews/sections have a major responsibility in keeping up with their BII, special tools/test items. TMs have also been included for comparison.

Closely related to BII, special tools, and test equipment are the other ancillary items required for operation and maintenance of the system. While new or revised TO&Es may include ancillary items required for the system, it is unusual to find all items available upon fielding. Often, commands are required to shuffle assets internally to make the required items available for a newly fielded system. This is a painful and complex process for field units, where property accountability is a difficult task even with such equipment transfers.

In addition to complications caused by support items, new systems are fielded with ancillary items so complex that a separate PM manages the item. The Black Hawk helicopter contains a doppler navigation system managed by the PM, Navigation Control Systems. The ITV is being fielded with a Night Sight, AN/TAS-4, which requires several major pieces of test and maintenance equipment. The night sight is managed by a different PM,[19] which means that three

19. PM, Manportable Common Thermal Night Sights.

FIGURE 1
System Support Items

SYSTEM	TMs	ITEMS OF BII	NUMBER OF SPECIAL TOOLS & TEST ITEMS (Org. DS/GS)
TACFIRE	54	24	7 kits, spt. vehicle w/2 men 2 GS Test Sets Module Test Set
M198 HOWITZER	9	45	12
BLACK HAWK HELICOPTER	40	-	64
M60A3 TANK	67	77	192
IMPROVED TOW VEHICLE	50	43	25
AH-1S HELICOPTER	115	-	35, plus 11 special kits

SOURCE: Materiel Fielding Plan for each system.

separate PMs are involved with the fielding of the ITV system. A somewhat exasperated member of a major command attempting to manage such fieldings stated:

> The point to be made here is that in order to successfully field a fully operational, sustainable ITV, we must deal not only with PM ITV for the vehicle itself, but also with PM TOW/DRAGON, CERCOM, ERADCOM, and the Night Vision Lab for the night sight, and with TARCOM for the trucks to haul test equipment, and TSARCOM for necessary generators. The notion that a single DARCOM PM can tie everything needed for fielding together is false.[20]

FACILITIES PLANNING

Although "facilities" is one of the original elements of ILS which has been recognized in DOD since the early 1970s, it tends to receive scant attention unless the system has major construction requirements. Recently, the issue of construction requirements has become even more critical, as existing facilities are already used to full capacity, and any funds for expansion are extremely difficult to obtain. The situation in USAREUR perhaps speaks for most of the major commands:

> Utilization of USAREUR facilities currently approaches 100% and many of the existing facilities (for troop and family housing, admin, maintenance, ammo, POL, etc.) are less than adequate to support current requirements. The introduction of new equipment often adds requirements for new facilities, and [it is] not always immediately apparent that facilities will be required for a particular system.[21]

The special management of construction funds requires that facilities be planned and programmed much earlier than other fund categories. Additional information and justification are needed for budget input, both at the major command level and at DA level. Some facilities may require modification, repair, refurbishment, or additional power-handling capability before new equipment arrives. Without a careful on-site survey by the developer and the receiving command, deficiencies will exist at fielding time.

It has become clear that the facilities area is one that needs greatly increased

20. Colonel James Ray, Chief, Force Modernization Division, USAREUR, letter to author, 14 December 1979.

21. Letter from Colonel Ray.

attention by the developer, to include planning and budget programming that begins more than 5 years before fielding.

DISTRIBUTION PLANNING

The distribution plan for a new system is an important aspect of the materiel fielding process. After selection of the IOC unit, new equipment distribution is prioritized and scheduled, based on availability of delivered systems from the contractor/production facility.

Some confusion has entered the planning process as DARCOM and DA occasionally accomplish parallel plans that do not always agree. DA uses the Basis of Issue Plan (BOIP) and the DA Master Priority List (DAMPL) to establish a distribution schedule, while in DARCOM the "item manager" or PM representative makes his own plan which may follow a different priority system. This confusion often results in a series of changes to the distribution plan that will have a major impact on gaining commands/units. The problem was pointed out in the 1978 AH-1S Report on Deployment to USAREUR and CONUS:

> The distribution plan for the AH-1S has been in a constant state of change since CY 1977. The original plan proposed distribution to certain installations in blocks of four aircraft. . . .The plan was then revised by DA to reflect aircraft issues in blocks of nine or more. At a later date, the schedule was revised by DA to implement certain ASARC III provisions. Still another DA revision reflected new DAMPL considerations.

Similar problems are caused by changing the IOC unit. Because final operational tests are often conducted by the IOC, changing the IOC unit can have a major impact on an installation/unit. Although the needs of the Army necessarily change over the long development cycles, an important objective for both the PM and the DA staff should be careful selection of the IOC unit, followed by strong resistance to any change as IOC approaches. Several of the systems studied changed IOC units after the initial selection.

Operational Testing

After the production milestone, a major system will normally undergo an initial production test and some type of operational test, such as a follow-on evaluation or force development test. If DT/OT II reveals significant deficiencies, a DT/OT IIa or III will normally be required before the production decision.[22]

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22. AR 1000-1, 1 April 1978.

Some type of post-production operational testing is necessary to demonstrate reliability, availability, maintainability (RAM) of the production equipment, and determine the suitability of logistics, training, and mission performance in an operational environment. Figure 2 shows the type of post-production test conducted by some of the recently fielded systems.

Except for the TACFIRE FOE, each test preceded IOC by a short period of time. The tests for M198, Black Hawk, and TACFIRE were all conducted by the IOC unit, and all were fielded in CONUS. The other systems were fielded in Europe, where it is apparently not feasible to conduct formal operational tests. One important conclusion can be drawn from these tests: Fieldings are much smoother when the IOC unit is also the final operational test unit. When this condition does not exist, a major burden is placed on the fielding team and the major unit involved.

Planning and preparation for the operational test should be a high-priority item for the PM, and his counterpart, the TSM. Recent fieldings show there are several key areas that require special attention.

TEST PLAN

The test plan should be a joint effort by the PM, TSM, and OTEA, with careful consideration to the key factors of test objectives, evaluation criteria, mission profiles, and resources required for the test. The test location is also very important and should be coordinated and approved at least 18 months before the test. Because the test will have a major impact on the installation and command involved, the installation commander should concur in the decision to conduct

FIGURE 2
Operational Tests

SYSTEM	IOC	TYPE TEST
M198	April '79	Follow-on Evaluation (FOE)
BLACK HAWK	Nov '79	IOC-Force Development Test Experimentation (FDTE)
ITV	Jan '80	FOE
M60A3	June '79	OIC-FDTE
TACFIRE	April '79	FOE

the test. Late changes in test locations can have a severe impact on all parties. The program office should have representatives present throughout the test to assist with unforeseen problems and observe the performance of the equipment. Also, PM/TSM representatives must be alert for system-related deficiencies that might affect the orderly accomplishment of the test. As system failures begin to occur, the PM will be reminded of the critical need to ensure that RAM scoring parameters are established before the test (and agreed on by the TSM and OTEA), and scoring conferences held during and after the test.

MAINTENANCE/TRAINING SUPPORT PACKAGES

Planning for both the operational and development tests is accomplished by means of the test working integration group (TWIG). The TWIGs present a series of forums where plans and potential problems can be discussed by all the principals involved in the tests. While there are a large number of items to plan and coordinate, one that deserves special attention is the support packages for the test. The program office must design a "package" of spare parts, tools, test items, expendables, BII, TMs, and other items needed during the conduct of the test. Any shortages affect not only the validity of the test but also the confidence the test troops have in the new equipment. An incomplete or late support package is grounds for OTEA to delay start of the test.

On recent tests the training support package has become as much a problem as the maintenance package. While operators usually receive the necessary training, maintenance personnel and test cadre have been neglected in the test preparation.

REVIEW OF EPRS, OTIRS, AND SPRS

As occurred with the M60A2, systems continue to be fielded with known deficiencies that were discovered during testing but were not corrected. Nothing can be more troublesome to members of the receiving unit who happen to be aware of them. A specific plan for review and action on test deficiency reports is an important aspect of readying the system for fielding.

Equipment performance reports (EPRs) result from development testing, while operational test incident reports (OTIRs) and system performance reports (SPRs) result from operational tests. An audit and tracking system should be established to ensure that each report is closed out with some form of action. This system should include review by the TSM for the non-routine reports. Those reports that result in system changes, engineering change proposals (ECPs), or technical manual changes should be carefully annotated to reflect that such action was taken. All other reports should reflect that some final action was taken, or that no action was necessary.

Not only do these test incident reports receive inadequate follow-up action, but overall test results that specify system deficiencies often do not result in system modifications. In each of the earlier operational tests (OT I, OT II) the findings normally specify that deficiencies will be corrected prior to the next test. With the conduct of the final operational test, there is virtually no means for ensuring that corrective action has been taken. Once again, the party who suffers is the user, as he starts the painful process of "maturing" the system in the field.

While all of the recently fielded systems experienced deficiencies during their final operational tests, no one expected any of the complex new systems to complete the test without problems. In some cases, the problems went beyond deficiencies with the new system. As an example of the potential difficulties, problems experienced during the M60A3 IOC-FDTE are worthy of review. The OTEA Independent Evaluation Report of June 1979 listed the following problems and deficiencies:

1. Test location changed from Fort Carson to Fort Polk just 7 months before the test.
2. The test tanks arrived late, and tank gunnery problems forced the test directorate to eliminate all tactical exercises.
3. After completion of the test, ARRCOM discovered that all M35E1 periscopes were defective. Later the M10 ballistic device was found to be defective. The validity of all test hit data was therefore questionable.
4. The maintenance support package was incomplete, and test time restrictions prevented a complete assessment of logistic support under field conditions. No evaluation was made of mechanic training or overall logistic support factors.

The report also stated that the M60A3 tank without the tank thermal sight (TTS) did not provide a significant increase over the M60A1 (RISE passive) in ability to accomplish the mission. This finding is of particular importance because the initial battalions of M60A3s already fielded in Europe do not have the TTS. It will undoubtedly be disturbing to these battalions to learn that the Army plans (under the foreign military sales program) to sell Egypt 244 M60A3 tanks beginning in December 1980.[23] These tanks will have the thermal sights, resulting in a foreign army achieving a capability before a number of high-priority U.S. Army units.

23. *The Washington Post*, 14 March 1980.

New Materiel Release Procedure

DARCOM Regulation 700-34 requires detailed certification of system suitability prior to release to the field (see introduction). While the procedure serves a necessary and worthwhile purpose, there are several problems with the procedure. First, there are inadequate checks on the requirements of the regulation to ensure that systems approaching fielding are accomplishing release requirements. For example, the TACFIRE system did not receive release certification until after IOC and fielding. The Black Hawk system was initially fielded with no release whatsoever. However, a release was processed and approved by the Black Hawk project manager on February 11, 1980.

Major systems routinely receive "conditional" releases because of shortcomings in such areas as logistical support and incomplete test results. The M198 Howitzer, ITV, M60A3, TACFIRE, and AH-1S all received conditional releases. Fielding with a conditional release does not require a statement of an "urgent" requirement for the new equipment. While it is a rather simple matter to provide a written justification for an urgent requirement, the real urgency in the field is sometimes difficult to understand. For example, the M551 was fielded under stated conditional and urgent conditions, but even a congressional committee failed to see the urgency. The fielding of the M198 Howitzer was considered urgent, despite the fact that only a single battalion was equipped, followed by an 18-month gap until other units were equipped.

The regulation requires that the user formally agree to all system deficiencies that bring about the conditional release. There is no documentation to reflect that the user agreed to the conditional release of either the M60A3 tank or the ITV. Finally, the intent of the regulation is not to achieve a materiel release prior to IOC and fielding, but to assure that Army materiel complies with all requirements prior to release for field issue.

There is no doubt that the materiel release procedure is not only desirable but also essential to ensure that only safe, supportable, completely tested equipment reaches the field. It is even more unfortunate that these deficiencies usually have major impact on the user.

TRADOC System Managers

The Army studies that led to the establishment of the TSM concept included:
—Total Tank System Study (T^2S^2)
—Anti Armor System Study (A^2S^2)
—Tank Forces Management Group (TFMG) Review
One of the important findings of these studies was that the Army's combat capability and operational effectiveness were drastically reduced by lack of plan-

ning for the personnel, training, and logistics aspects of new systems. The Army realized that its weapons acquisition programs had been hardware oriented, with little emphasis on critical supportability needs after fielding.

The Army's TFMG Review,[24] conducted in the 1976-77 time frame, could be used to point out many of the "total system needs" of all new systems, not just tank systems. It recommended the following:

—Separate career field or MOS for new systems
—System-qualified and trained NCOs
—A dedicated weapon management office at selected levels
—Entry-level training for officers in the new system
—Revised curricula at NCO schools to teach system technical skills
—Revised maintenance/log training to accommodate the new item
—Spare parts stockage based on wartime need, rather than training demand/usage
—An integrated system for resupply/rearm of the new system

Implementing these recommendations just for new tank systems would be challenging enough (and is being attempted), but to expect to do the same for every new system would tend to overload the Army's existing training and personnel system. And yet these tasks are representative of what each TSM strives to accomplish for his system.

Although the concept has been in effect for only a short time, it is possible to view some experiences and lessons learned from the TSMs of the recently fielded systems. Detailed letters were received in answer to the author's questions to TSMs about the fielding of their systems.[25] Their verbatim comments in selected areas provide valuable insights.

Concerning influence on system design, system changes:

> The user had very little influence on the initial design since three different corporations provided three different designs, each with unique configurations designed to meet the ROC . . . (regarding system changes/improvements) that did not entail coordination with more than one PM, the task was fairly easy. If two or more PMs were involved, it became very difficult . . . about the only way to get realistic schedule and cost impact was to request

24. Lieutenant General James G. Kalergis (Ret.), Total Tank System Study and TFMG, discussed in *Armor*, July-August 1977, pp. 5-11.

25. Comments taken from the following letters: Colonel W. E. Davis, TSM, ITV, 11 January 1980; Colonel C. F. McGillicuddy, TSM, Black Hawk, 3 December 1979; Colonel Frank Day, TSM, M60A3/XM1, 30 November 1979.

DARCOM convene a meeting between the PMs involved and the TSM.

My office developed the philosophy of holding the requirement still and not changing it and let the developer do his job. As a result, there have been only two changes since 1971 and both were to eliminate requirements. I will admit that the production version represents old technology (in today's world) but we can improve it, and we are able to field a system that we can identify, train against, issue pubs, and logistically support.

Concerning funding problems:

The recurring problem is to rejustify funding on an annual basis. Delays in development, changing priorities and budget considerations beyond the control of the PM and even the Army cause havoc for lower priority work. In particular, training devices and ILS elements are vulnerable because of their perceived lower priority.

Budget for ASL/PLL was not adequately planned for by TRADOC, FORSCOM and USAREUR. . . . With all our expertise in costing we still have trouble in estimating the cost of unit training. The need for a cost of training and effectiveness analysis (CTEA) has been demonstrated time and time again.

Concerning transition training for the new equipment:

All transition training package developers are forced by real constraints of time and money to make certain assumptions regarding the state of training of the unit to transition. This "training baseline" represents assumed skills needed to complete transition training but that will not be taught during NET. The training developer is inclined to make an imprecise and excessively broad assumption on the unit's training baseline. Unit commanders have ignored the assumed baseline warning due to the press of other problems, even after we have provided a defined baseline and the opportunity to conduct remedial training, if required.

Concerning IOC and actual fielding:

IOC is a myth. It is when the unit is fully equipped, personnel have been trained in operation and maintenance and have the necessary tools, spare parts and pubs to maintain the equipment. Then the unit training can begin. There are others who maintain that IOC does not occur until the unit is trained. If we attend to this philosophy, then in some cases, IOC may never occur. IOC is merely a target date . . . most IOCs are classified which is patently ridiculous.

> Current regulations that mandate a simultaneous fielding of a system, its technical, training and doctrinal documentation and fully developed and tested training devices are not realistic. . . . It can waste vast sums of money through continued revision of support systems to reflect unanticipated but necessary changes in the supported system.
>
> The "players" change more rapidly in USAREUR than in CONUS. Briefings designed to coordinate (fielding requirements) were seldom attended by the same people twice. Hence transient management threatens early achievement of operational readiness at every step in the fielding process.

Concerning operational testing:

> The influence of the mission proponent for the system is considerable. The problem is keeping outside agencies from entering non-significant issues into the test.
>
> We generate critical issues for test, the training package, comment on all coordinated test plans, participate in judging the result, and in briefing the findings to decision-makers. We see the operational test as a testing vehicle for training and logistic packages for use in fielding and beyond.
>
> A continuing problem in the management of testing in the Army is failure to develop and staff test issues early enough so that the test design can be developed and integrated into the test to answer relevant issues. . . . We have difficulty coming to grips with the criteria against which a particular issue is to be evaluated. If the criteria cannot be measured then it is not an evaluation tool. If it cannot be measured, the user, TRADOC cannot force the PM to meet that particular criteria. . . .The single area where TRADOC, DARCOM, and OTEA had the most difficulty was establishing acceptable failure definition and scoring criteria to be used as a basis for generating RAM computation.

The TSM regulation (TRADOC Reg. 71-12, September 15, 1978) specifies that the TSM ". . . will insure that training personnel, and logistical subsystems are developed which will meet the user requirements. . . ." The subsystem development process is a cooperative activity with the project manager and the center/school that has system proponency. Although not specified as a TSM task, the TSM must also develop an operational employment concept for the weapon system.

But the real challenge for the TSMs managing major new systems will be in the areas of manpower and training. Recent Army studies (unpublished) project

that it will not be possible to produce the large numbers of skilled soldiers required for all the new systems coming on line. Also, new systems require noncommissioned officers as section/crew chiefs. Where will they come from? If they are taken off other systems and retrained, the problems of phasing in new systems and phasing out old systems become a major management problem well beyond the capability of the TSM.

Training for major new systems presents an even wider range of challenges. The skyrocketing costs of ammunition, fuel, and repair parts bring about the need for innovative approaches to training. Training devices, simulators, and visual aids for both operators and maintenance personnel should be a high priority effort as the training system is developed.

Impact of Fielding on the Command/Unit

Major commands are in the process of developing a structured, institutionalized system to manage the fielding of new systems. "Force modernization" offices can now be found at all levels of the Army down to the division. Commands such as USAREUR are moving out aggressively to gain control of the complex fielding process and are beginning to issue their own detailed deployment plans for new items. USAREUR, for example, issued a deployment plan for the improved TOW vehicle.[26] (The PM was not on distribution!)

But the major concern of the modernization offices is the budget/funds impact of the new systems.

> By far the greatest challenge in fielding new equipment in USAREUR is the requirement to reconcile the event-oriented Life Cycle Management Model (of DA Pam 11-25) with the calendar-oriented events of the USAREUR PPBS.[27]

In an attempt to assist gaining commands in the fielding requirement and close the "information" gap, the Army has started to publish a compilation of data on all new systems, known as the Army modernization information memorandum, or AMIM.

THE ARMY MODERNIZATION INFORMATION MEMORANDUM

In October 1979, DA published for the first time a detailed description of new equipment that would be fielded in the next 5 years. The Army modernization information memorandum (AMIM) provides major commands with planning and

26. USAREUR Deployment Plan for the Improved TOW Vehicle (M901) and TOW Night Sight (AN/TAS-4), 17 October 1979.
27. Letter from Colonel James Ray.

resource data on both major and non-major systems over the PPBS cycle.

The AMIM played a major role in bringing to light significant problems in the planning and programming process accomplished by major commands in the area of new equipment. Without detailed information from the materiel developer, the commands were unable to project requirements adequately in such areas as facilities/construction, stock funds for repair parts, and personnel and training requirements. Now that much of this information is available, some commands are projecting major shortfalls and have even stated that fieldings should be delayed until required resources are available. Another point that has emerged from this exercise is that there is more than one "bow wave." Besides procurement dollars, operations and maintenance dollars in the out years have also become critical. The second bow wave is also called the "undertow," since it pulls down readiness posture because of insufficient stockage of repair parts.

While the command is managing these funding problems, it will also be faced with some difficult unit-level problems that require careful planning and coordination with the DARCOM fielding activities.

TRANSITION TO NEW EQUIPMENT

Activity at the unit level includes a myriad of tasks in anticipation of the arrival of the new equipment. Some of the most important activities are:

—Turn-in of replaced item
—Unit training for the new item
—Build up and management of repair parts for new items
—Changeover/issue of system support items, such as vehicles, generators, ammunition, and communication items

Each of these areas requires careful planning and a dedicated, coordinated effort by the major command, the PM, and, of course, the unit involved. Experience with the recently fielded systems points out that no matter how detailed or complete the planning may be, problems will still arise. There is a need for new thinking in the formulation of materiel-fielding plans and fielding agreements. These plans are written from the DARCOM point of view in a more or less standard format that often does not take into account peculiarities of the command and unit involved. In most cases there has been no direct memorandum of understanding (MOU) with the unit involved, which leads to considerable misunderstanding and information gaps.

While the intent of the statement of quality and support (SOQAS) process is to achieve "total" user satisfaction and support, in some cases the user or IOC unit has been far from satisfied. The commander of the M60A3 IOC battalion in Europe had these comments:

> The most significant problem [during fielding] was the lack of official information provided to the battalion during the entire period. . . . Lack of official information created changes and turmoil based on unofficial rumors from staff section above the battalion.[28]

The same commander also commented that his first notice (official or unofficial) about the transition to the new tank was received in November 1978 for the fielding that was to begin in May 1979. He also made a detailed record of problem areas during fielding. Ironically, many of the same problems had occurred in the same battalion 3 years before when the M60A2 was fielded:

—Criteria for turn-in of old tanks changed almost monthly.

—Difficulties were experienced with ammunition requirements.

—Problems were experienced with critical MOSs for the new tank.

—The new tanks exhibited poor quality control during manufacturing requiring ". . . 2-3 days concerted effort for each tank crew to correct."[29]

—Numerous problems with the fire control items (manufactured by the same contractor as the M60A2 fire control).

The command will also have to contend with a readiness impact as the old equipment is prepared for turn-in and the new equipment is not completely issued or operational. One command asked (and received DA permission) to retain the replaced item for a 90-day period after IOC so that either would be available in the event of a contingency requirement.

There are other examples where complete planning with continuously updated MOUs between the PM and the unit failed to prevent major problems that delayed achievement of a full operational capability. The system involved employed a critical data link that proved to be incompatible with its critical subscribers. Additionally, a requirement to employ the system out of bunkers proved to be very difficult to accomplish in the "real world." In both cases, the potential problem was known before fielding but controversy over responsibilities, particularly funding, prevented resolution before the equipment was put in the field.

28. Lieutenant Colonel Thomas L. Beale (Commander, 1st Bn, 32d Armor), After Action Report—M60A3, 1 August 1979.

29. In January 1980 the author visited the M60A3 tank plant in Warren, Mich., and asked the Plant Commander about feedback from Europe that was significant enough to warrant changes in quality control procedures. He stated that he had heard of no problems that required any changes.

Contractor Maintenance Support

As new equipment has become more complex, the system contractor must often provide on-site assistance for a temporary period after fielding. After initial problems are solved and Army-trained maintenance personnel become proficient, the contractor personnel normally depart. In some cases, a contractor repair capability for selected components has also been necessary.

While these procedures can save money and reduce the burden of maintenance training immensely, the Army has attempted to avoid the contractor approach as a general principle, despite the fact that directives (such as DODD 4151.1) encourage use of contractors. It is true that the results of most of the temporary arrangements have been satisfactory, with the exception of the "withdrawal" problem discussed in the M60A2 section.

Army electronic and missile systems are a special case in point. Traditionally, these systems have relied more heavily on contractor support than other systems. In some cases, contractor maintenance is a full life-cycle requirement, rather than a temporary phenomenon. There appears to be a trend toward even more contractor dependence with new systems to be fielded in the next few years.

The TACFIRE system, for example, was fielded with a contractor-dependent maintenance/repair concept. After more than a year in the field, the system is still experiencing problems with the response time and overall management of the concept. The TACFIRE system was intended to make the transition to "normal supply support" procedures on March 1, 1980, but did not succeed.

Current plans for the PATRIOT missile system call for a method of built-in tests for fault isolation with little or no test equipment such as is used with most other missile and electronic systems. Faulty battery-level replaceable units will be transported directly to the contractor for repair. The plans for the soon-to-be fielded Stinger missile system also contemplate a roving contact team for maintenance above organization level, with no other military capability between organizational and depot level.

Missile/electronic systems are not the only systems that will be relying on contractor support. The Black Hawk system is using the contractor for both wholesale supply support and depot maintenance through March 1982. (Separate contractors are involved for the air frame and engine.) Although not all national stock numbers (NSNs) have been assigned, the system utilizes standard requisitions to the contractor, which will make conversion after March 1982 much easier. Although this system has been in operation for only a few months, it is operating effectively so far.

These contractor-dependent systems raise questions in addition to the obvious

ones about operation and support under a conflict situation.[30] How will the prioritizing, collection, and transportation of faulty components be managed for the yet-to-be-fielded systems? Also, determining criteria for contractor float and DX items, funding, and location of repair facilities will require careful planning.

Another related issue involves the often-heard claim that Army equipment is becoming overly complex and difficult to operate. The Army is attempting to dispel this idea. In its FY 81 statement to Congress on RDTE and procurement requirements, the Army addressed the issue this way:

> The question, as usually put, is where is the country to get the Army of PHDs that will be required to operate all this sophisticated, complicated hardware? The answer is that these systems will not require engineers to operate or maintain them in the field. On the contrary, most of the weapons are easier—sometimes radically easier—to operate than systems they will replace. . . .The new systems have been designed with the troops in mind—*their sophistication is internal* (emphasis added).

While simplicity of operation may be a fact, the potential problem area caused by the "internal sophistication" is complex maintenance and repair. Soldiers may be capable enough to operate the equipment, but repair and maintenance may present a challenge to the Army that can be solved only by lengthy maintenance training schools, and use of on-site civilian contractors for extended periods. While the Army is taking both approaches, the trend is for even greater contractor dependency as contracts contain more and more logistic and supportability requirements.

Of all the recently fielded systems studies, only one (M198 Howitzer) did not rely on contractor technical assistance and component repair for at least a temporary period.

Despite these issues and potential problems, there are good reasons for contractor support. The major maintenance training resources required for the fielding of a new system can be greatly reduced by reverting to contractor support. Also, the American soldier is just not capable of learning the complicated maintenance and repair of many systems without an inordinately long training period. The advantages of contractor support must be balanced against the disad-

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30. The Navy has relied on civilian technical representatives aboard ships since before the Vietnam conflict. Although they stayed aboard during the Vietnam conflict the only complaint heard was that they were making more money than the ship's captain.

vantages of dependency on a contractor who may not be around in a conflict.[31]

Summary of Major Lessons Learned

INTEGRATED LOGISTICS SUPPORT

—Provisioning is a long lead time activity that requires careful monitoring.
—Technical manual development requires frequent soldier validations.
—BII, special tools, and TMDE add considerable burden to the weapon system and supply system.
—The construction, repair, or refurbishment of facilities required for the fielding of new weapon systems has received inadequate developer management attention.

OPERATIONAL TESTING

—The test plan should be a carefully coordinated effort by the TSM, PM, and OTEA or test agency.
—Maintenance and training support packages need additional emphasis to ensure complete availability at test start.
—A tracking and audit system is required for all EPRs, OTIRs, and SPRs.

NEW MATERIEL RELEASE

—Not all release requirements are being accomplished.
—Excessive conditional releases have led to institutionalized release of new systems with numerous deficiencies.

TRADOC SYSTEM MANAGERS

—TSMs face major challenges in developing and fielding adequate and on-time personnel and training systems.

IMPACT OF FIELDING ON THE COMMAND/UNIT

—The major (receiving) command must reconcile the life-cycle management system with the PPBS for each new system.
—The receiving command must develop a fielding/transition plan in coordination with the developer's MFP.

CONTRACTOR MAINTENANCE SUPPORT

—New systems are relying more and more on post-fielding contractor support.

31. Some of the information for this section is based on a January 1980 interview with Lieutenant Colonel Larry Capps, former Commander of 3d Ordnance BN (USAREUR) and member of Patriot Project Office.

—As system maintenance and supportability requirements have increased, the Army has shifted much of the related development tasks to contractors.

CONCLUSIONS AND RECOMMENDATIONS

Documenting Lessons Learned

An important recommendation at the outset concerns the need for documenting and making available lessons learned about the fielding process. This research effort revealed the following:
—Few lessons learned are documented.
—If documented, they are often filed in the originating office, or sent to a functional office with little or no opportunity for use by a future PM.
—Lessons learned presented at PM conferences are seldom retained on file, or shared with the working level at the project management office.

The new DARCOM Regulation 700-15 requires a lessons-learned summary ". . . within three weeks after completion of the DARCOM effort in the gaining command." This requirement, if enforced, will be an excellent first step. An official repository for lessons learned needs to be designated. Those that exist are scattered throughout DARCOM with some concentration in the Office of Project Management. The Defense Systems Management College should also be considered as a repository.

The practice of submitting DARCOM Form 2410-R has proved totally ineffective as a follow-up check after fielding. The only action taken by the addressee of the form, the materiel readiness support activity (MRSA), is compilation of a statistical report to Headquarters, DARCOM, which in turn either files the report or compiles a summary report for the command group. There is no evidence that any action has been taken by DARCOM as a result of negative 2410-R answers submitted by an IOC unit.

Establishing an IOC Date

The major problem with IOC dates is that they are set too early in the life-cycle and are often based on risky estimates of program time requirements. The benefits of setting a fixed IOC date outweigh the benefits of setting a more flexible date, but the date should be *reconfirmed* at the production decision milestone. The adverse impacts of accepting many deficiencies if the IOC date is to be met may justify delay. The opportunity for an "official" extension, if necessary, will help all parties planning for the forthcoming IOC.

ILS Activities

The concern (and budget support) for the various ILS areas is beginning to go

beyond the lip-service stage. The major budget impact and detailed planning necessary for such activities as initial support items and facilities require acquisition managers at all levels to concern themselves with areas previously "left to the logisticians." The central ILS concept that the entire logistic system must plan and prepare for each fielding is proving to be the key factor in achieving a successful fielding. The recent passage of a revised DOD directive on ILS[32] will further support increased emphasis.

A critical requirement is determining the complete needs of the system in the areas of repair parts, special tools, TMDE, and ancillary items that are essential to system operation and maintenance. This includes the responsibility to ensure availability of these items at fielding time. The PM should ensure that proper management attention is also given to those items that are the responsibility of item managers and the receiving command.

The trend toward increased contractor responsibility for critical ILS functions should cause some concern. Production contracts often contain requirements for delivery of a support package that can include a complete provisioning effort, technical manuals, trained operator and maintenance personnel, training devices, and system maintenance and repair capability that supplants the Army depot system. While this approach shifts a major burden from the program manager to the contractor, there are at least two potential problems with this approach:

—Program office has reduced visibility and control over critical ILS activities.

—DARCOM managers of the affected ILS areas may be slowly put out of business.

The ability of the contractor to accomplish effectively highly complex ILS activities (that the Army has had difficulty accomplishing in-house) is also an area of concern.

The issue of who pays for the initial support items will continue to be debated. The USAREUR experiment with the fielding of M113A2 and ITV PLL/ASL through carefully managed package shipments proved reasonably succesful, but failed to change the existing policy that requires the receiving command to fund the initial support items. It seems clear that as part of SOQAS, DARCOM should manage the setting up and funding of initial support items for at least the first unit equipped or IOC unit. If the philosophy of SOQAS and hand-off is to be meaningful, the major burden of conversion and management of the initial PLL/ASL, special tools, and test equipment should be carried by DARCOM and the MFT,

32. DOD Directive 5000.39, Acquisition and Management of ILS for Systems and Equipment, 17 January 1980.

not the unit. Field units are ill-equipped to manage the complex conversion to a major new piece of equipment.

A final conclusion in the ILS area concerns the need for more active participation by logisticians in the planning and decision reviews during system development. Several key managers at the policy and operating level commented that major logistics deficiencies still exist because logisticians do not actively participate in decisions, reviews, and planning sessions. Rather than standing by and saying, "Tell me what you want done and I'll do it," the feeling expressed is that the logistician must predict problems and aggressively insert himself into the process.

Operational Testing

A major effort should be made to conduct the final operational test at the IOC unit/installation. The benefits to fielding are numerous, and the unit/command involved will achieve IOC in a much higher state of readiness.

DARCOM's record of availability of required resources to begin an operational test needs to be improved. Both maintenance support packages and training support packages have been deficient in the past. Systems to be tested have arrived late and with hardware deficiencies that affected the test outcome. Test units are not provided adequate manuals, BII, special tools, and ancillary items that are an essential part of the total system, reducing troop confidence in the equipment and affecting the validity of the test results.

As logistics and supportability factors of new systems become more complex, the ability of operational tests to evaluate all supportability requirements adequately has diminished. The combination of not enough time and non-availability of key system support items has resulted in many systems advancing to fielding with a support and maintenance concept that has not been adequately tested in an operational environment. At a minimum, a follow-on evaluation should be required after IOC to test, in an operational environment, all major supportability factors. Such an approach is being followed by the Infantry Fighting Vehicle (IFV) program.

New Materiel Release Procedure

The provisions of DARCOM Regulation 700-34 are valid and should be complied with by all system managers. Certain aspects of the regulation are not being enforced, while others have brought about a condition of institutionalized acceptance of new systems with excessive deficiencies.

Because most major systems are released under conditional circumstances, there is a need for at least two categories of conditional release. One should specify that certain deficiencies must be corrected before IOC, while the other can

remain essentially as currently written. The "user agreement" to the conditional release should include both the system TSM and a representative of the gaining command/unit. It is not possible for the TSM alone to be aware of the full range of impacts that the various system shortcomings will have.

TRADOC System Managers

TSMs are having a favorable impact on the development and fielding of new systems. While the personnel and training problems associated with new systems are far from solved, at least a focal point of responsibility is now part of the acquisition community. Since experience has shown that simultaneous fielding of the new system with a revised MTOE, all personnel and equipment, and a complement of fully trained personnel with new MOSs is often not possible, a concept of phased fielding of these activities should be developed. The development of the training base with efficient but expensive training devices should also be phased in to prevent wasted expenditures for a new system that might be canceled or delayed after only a limited production.

TSM responsibilities need to specify the requirement for formal development of an employment concept, particularly for systems that employ advanced technology weapons and systems. Since the PM and most of his personnel have technical backgrounds, it is only natural that they concentrate on technical development problems rather than employment concepts. The TSM should fill this void and systematically develop an employment concept in parallel with the personnel, training, and logistics system.

Impact of Fielding on Command/Unit

The concept of force modernization offices should be institutionalized, but the issue of proponent staff agency needs more study. The majority of fielding issues are logistics oriented; thus, more consideration needs to be given to establishing the office under the DCSLOG rather than DCSOPS.

Efficient fielding requires simultaneous accomplishment of a wide range of activities at all levels of the chain of command. The MFP cannot address (nor was it intended to address) all these activities. Major commands should have their own fielding plan for each system, addressing such issues as turn-in of replaced items, unit training and personnel requirements, and management of support items. The MFA and MOU should clarify responsibilities in all such areas, and should designate a single PM as the point of contact for the gaining command/unit for those systems with multiple PMs involved.

The MFT needs to ensure that new equipment passed off to the unit has been 100 percent checked for deficiencies, has complete manuals and BII, and is ready

to perform its operational mission. The SOQAS period should cover the complete fielding period, not just the transition training period or limited hand-off period.

Contractor Maintenance Support

The use of contractor maintenance and repair should be avoided. Program managers who propose a temporary period of contractor assistance after fielding should be required, at key briefings such as LOGCAPs, DAPRs and ASARCs, to present a plan for transition to Army-only support.

The trend towards shifting more and more of maintenance and repair requirements to contractors should also be reconsidered. The expertise and capability of many contractors to accomplish these requirements adequately over the long term, and in a conflict environment, is not always evaluated.

Needed: A DA Fielding Policy

With some 50 new major systems to be fielded in the 1980-85 time frame, the Army needs to develop a policy and a commitment to the fielding process. The DA force modernization office is the obvious management agency for such an effort, with DCSLOG and other staff agencies providing key inputs in their areas of proponency. The current DCSLOG efforts to update the regulation on integrated logistics support could be the means for an expanded effort to cover other areas related to fielding. The policy should include consideration of the ability of the average soldier to be trained to maintain and operate the sophisticated new equipment.

Another important issue concerns the extended development times that result in new weapons being fielded with "old" technology. One of the major reasons for congressional cancellation of the TACFIRE program was the concern that the Army was fielding a tactical computer system with 15-year-old technology. The M60A3 tank is being fielded with fire-control technology that is of the same vintage (1970) as its predecessor, the M60A2.

The shortened acquisition cycles for such systems as XM1, IFV, and MLRS are encouraging, but the acquisition times for these systems were mandated by Congress rather than planned by the Army. While the mandate shifts some of the acquisition "risk" to Congress, the Army needs to accept the risk and make the commitment itself to shorten acquisition times. This commitment and risk sharing must be carried by all members of the acquisition institution, not just the Army. Perfect information, confirmation of all program objectives, and the concurrence of the normal long list of agencies before a decision is made must become a thing of the past. DARCOM's Deputy Commanding General, Lieutenant General

Robert Baer, said this about extended acquisition times:

> No materiel system is ever going to be fully mature when it is fielded. No testing program, no matter how extensive and how costly, will ever expose all the problems. Systems grow to maturity only through experience in the hands of troops in the field. We have to say, at some reasonable juncture of proven performance, time and money, that, "we've gone about as far as we can go, get on with fielding.[33]

On the other hand, Lieutenant General Baer says, "I am not, however, advocating that systems be fielded simply because the schedule says it's time to field." Clearly, the Army must make the difficult decision for each system on a case-by-case basis.

The final aspect of the fielding policy should provide for the institutionalized commitment to user satisfaction and support at fielding. Not only should the provisions of SOQAS and hand-off be strengthened and expanded, but they should become the DA policy rather than a matter of choice by the developer.

SUMMARY OF MAJOR RECOMMENDATIONS

1. Lessons learned need to be documented, collected, and made available to program managers.
2. IOC dates should be formally reconfirmed at the production milestone.
3. Development of initial support items requires added emphasis to include evaluation of the trend toward increased contractor management of these activities.
4. The fielding and funding of initial support items for the IOC unit should be managed and paid for by DARCOM.
5. Logisticians need to play a more active role in the acquisition process, particularly DA-level planning sessions and decision reviews.
6. Conditional release (DARCOM Regulation 700-34) needs to be revised to define two categories, specifying certain deficiencies that must be corrected before IOC.
7. DARCOM should evaluate the trend towards increased use of contractors for accomplishing ILS tasks, and the increased reliance on contractors after fielding.
8. The final operational test should be conducted by the IOC unit.
9. OTEA emphasis on evaluating system supportability needs to be increased.

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33. Lieutenant General Robert J. Baer, "Keynote Address," printed in *Armor*, July-August 1979.

10. The TSM should be formally charged with the development of a system deployment concept.
11. Major command force modernization offices need to develop a regulation and procedure for materiel fieldings, to include guidance on turn-in of replaced items, unit transition training, and management of new support items.
12. DA needs to develop a fielding policy and a commitment to user satisfaction similar to the DARCOM policy.‖

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Joint Service Test and Evaluation

Brigadier General Jerry Max Bunyard, USA

Recent years have seen several changes in Department of Defense policy regarding testing in direct support of the weapon system acquisition process and other type testing. It was recognized several years ago that DOD lacked an effective method of conducting operational test and evaluation (OT&E) that cut across service lines, whether it be to support the acquisition process in a multi-service procurement, or to evaluate joint-service operating procedures. This deficiency was highlighted in The Blue Ribbon Defense Panel Staff Report, July 1970, which stated that the lack of joint OT&E

> . . . is particularly unfortunate since in most actual combat environments the Services must conduct combined operations. The interactions between Services become extremely important during combat, and critical military missions transcend Service boundaries and responsibilities (for example, Close Air Support, Reconnaissance, Air Supply). Because of the lack of joint OT&E, it is not only very difficult to predict combat capability in advance but it is also difficult to make decisions relating to overall DOD force composition.

Major improvements have been made in joint testing and evaluation (JT&E) since the Blue Ribbon Panel report.

History

In 1969, the President's Scientific Advisory Committee recommended to the Secretary of Defense that an operational testing organization be established in the Office of the Secretary of Defense. In its report the committee stated:

> We regard the creation of the testing and evaluation groups as the utmost importance, since we believe most of our previous failures to be prepared for wars we fight would have been thoroughly exposed had an adequate program of testing and evaluation existed. The actual tests are very expensive and since the Testing and Evaluation budget in a Service is often in competition with funds for new equipment developments, we believe it is vital that the Test and Evaluation groups in OSD have a substantial budget to allocate for tests.

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This statement holds true today. In the summer of 1970, a task group of the Blue Ribbon Test Panel made a study of operational test and evaluation in the Department of Defense. In the report to the President the Blue Ribbon Panel concluded:

> There has been, and is currently, no effective means for conducting productive Joint Operational Test and Evaluation (JOT&E). The fact that some efforts (for example, Joint Task Force 2) have encountered difficulties and achieved few useful results does not obviate the requirement for *much needed* JOT&E. . . . An early task and continuing responsibility for the OSD OT&E group should be to develop means to ensure that productive joint OT&E are accomplished when needed.

To implement the Blue Ribbon Panel's recommendations, Deputy Secretary of Defense Packard, in a 1971 memorandum to the OSD Staff, the Joint Chiefs of Staff, and the services, amplified the Blue Ribbon Panel's recommendation and stated:

> I want to encourage more joint operational test and evaluation, not only with respect to items which have a natural interface with equipment of another service, but also in order to provide more two-sided testing.

The Blue Ribbon Panel intended that there be—and DOD certainly needed– more realistic two-sided testing. An Office of the Assistant Director for Test and Evaluation was established in 1966 within the office of the Director of Defense Research and Engineering (DDR&E). In 1971, as a result of the Blue Ribbon Panel, the staff was increased and the office was designated the Deputy Director (Test and Evaluation), or DD(T&E). The DD(T&E) was assigned responsibility for initiating and conducting the JOT&E program. In 1977, the responsibilities for JOT&E were transferred to OASD(PA&E) for a short time. In 1978, these responsibilities were transferred back to the Director, Defense Test and Evaluation (DDTE), where they remain today.

Department of Defense Directive 5000.3 was published in 1971 and established the policy for the conduct of test and evaluation. It gave the Deputy Director (T&E) overall responsibility for test and evaluation matters within the Department of Defense. Individual responsibilities included initiating and sponsoring joint tests and evaluations. The guidance provided by this directive was very general; however, it did initiate the first JT&Es to be conducted under the new organization.

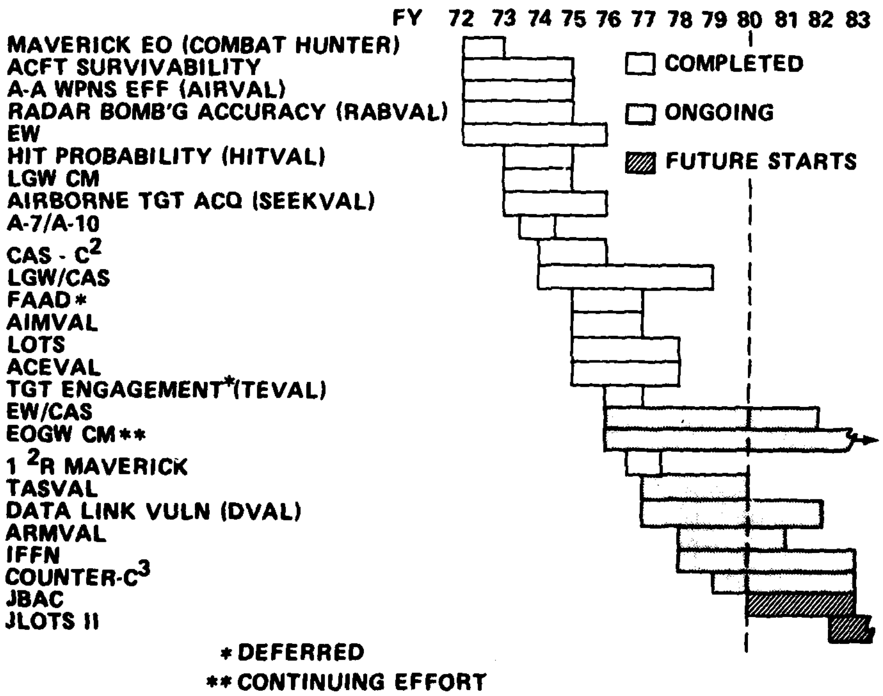
Five joint tests were started in 1972 from nominations made by the services and OSD. From 1971 to 1979, joint tests and evaluations were nominated annually by the JCS, Commanders in Chief, services, OSD, and agencies of the OSD at

the call of DD(T&E). In addition to the annual nominations, some tests were conducted to answer critical questions of the Congress and OSD on acquisition issues. Some tests were also carried out at the direction of the Secretary of Defense to address issues raised by the DOD Scientific Advisory Board. There are seven ongoing JT&Es. There are six additional potential JT&Es undergoing feasibility studies. Figure 1 depicts the JT&Es approved since 1972.

Purpose of Joint Test and Evaluation

Test and evaluation is a structured investigative process or procedure designed to obtain, verify, and provide data on which to base an assessment. The joint test and evaluation program of the Department of Defense is conducted to

FIGURE 1
Approved Joint Tests



answer questions concerning specific systems being developed (EO and I²R Maverick); as well as force structure and mix issues (ACEVAL, TASVAL, ARMVAL); and for gathering basic data for the analysis community (HITVAL, SEEKVAL, RABVAL, IFFN); and in assessing or developing pertinent information on doctrine, tactics and procedures in an operational environment (LOTS, ARMVAL, EW/CAS, IFFN).

Joint test and evaluation is generally conceptual rather than hardware-oriented. Existing, or sometimes surrogate, equipment and JCS/service-approved doctrine and tactics are used to gather baseline data, which are then used to evaluate and develop operational concepts and system requirements. Every attempt is made to conduct testing under as realistic operational conditions as feasible to provide a realistic environment and to conserve resources. JT&Es are scheduled in conjunction with JCS exercises whenever possible. The recent advances in instrumentation and computer software permit the collection of vast amounts of data from scheduled joint exercises without requiring special resources or interfering with the tactical conduct of the exercise; however, "piggybacking" on exercises has limitations if quantitative data is desired as a function of controlled variables. In this case, a certain amount of test control and replication of variables must be scheduled in the exercise.

Recommendations made to decision-makers by analysts, are for the most part, derived from theoretical data. This data base leaves much to be desired. Joint tests have helped improve the data base by providing analysts data from operational realistic engagements. Data from these tests come much closer to duplicating combat conditions. Millions of dollars are spent annually on studies and models attempting to satisfy the voluminous questions on weapon system acquisition. The joint test program is now providing for the collection of this much-needed empirical data.

Nomination and Selection Process

The early nomination and selection process was haphazard at best. Beginning in 1971, the Deputy Director (T&E) called annually for nominations of joint tests from the JCS and the services. The call was made in sufficient time for the tests selected to be included in the OSD budget request, but not always in time for the services to include test support costs in their budgets. DD(T&E) reviewed the nominations and selected those tests that he considered most appropriate. No formal instructions existed for preparing and submitting nominations, and they usually consisted of no more than a title and limited objectives.

Once a selection was made, a feasibility study of the test was conducted by an outside support agent under the direction of DD(T&E). When it was determined that the test was feasible, the study results were sent to the JCS, services, and in-

terested DOD agencies for comment and review. Based on this review, DD(T&E) affirmed the decision to proceed and initiated a test design. Lead and participating services were designated, and a Joint Test Director (JTD) was selected to execute the test. A Joint Test Force was formed under the direction and supervision of the JTD, who was directly responsible to the DD(T&E) for executing the test. The charter for the Joint Test Director was established by memorandum from OSD.

Recognizing the need to improve the overall JT&E program, the DDTE initiated a study in early 1979 to analyze the current JT&E process and to improve the overall program. The goal was to develop a mechanism to correct inadequacies in the planning, management, and execution of JT&Es. Results of this study were, first, a redefinition of the concept of JT&E (DOD Directive 5000.3, December 26, 1979) and second, adoption of a baseline architecture to significantly improve the overall JT&E process. Early and integrated planning is now being accomplished which is tied to the DOD planning, programming, and budgeting (PPBS) cycle. Significant actions that have been taken are as follows:

—The nomination process has been improved by requiring submission of nominations in sufficient detail for effective planning, programming, and budgeting. Nominations are made for the succeeding 5 years.

—A Joint Planning Committee and a Senior Advisory Council have been established within DDTE. The Planning Committee consists of members from DDTE, the services, JCS, and OSD. It reviews the nominations for completeness and the estimate of resources required. It also refines the budget and makes an initial determination of feasibility. The Planning Committee recommends to the Senior Advisory Council the joint tests that should be included in the JT&E Five Year Plan. The Senior Advisory Council, chaired by the Director, Defense Test and Evaluation (DDTE), with senior-level members from each service, the JCS, and interested agencies of OSD, recommends to the DDTE joint tests and evaluatons for execution. It also reviews JT&E policy and management, and recommends changes.

—Responsibilities and authorities of the DDTE, services, JCS, lead service, and the Joint Test Director have been more clearly defined.

—The Joint Test Director and the services are now more actively involved in the conceptualization and design phases of the JT&E process.

The recommendations of the study were implemented with the FY 1982 nominations in November 1979. A procedural manual that provides the overall JT&E architecture and guidance to the Joint Test Director is scheduled for publication by November 1980. This manual will formalize the JT&E process and provide direction and guidance for the conduct of future tests. The current JT&E planning process is depicted in Figures 2 and 2A.

FIGURE 2
JT&E Nomination and Selection

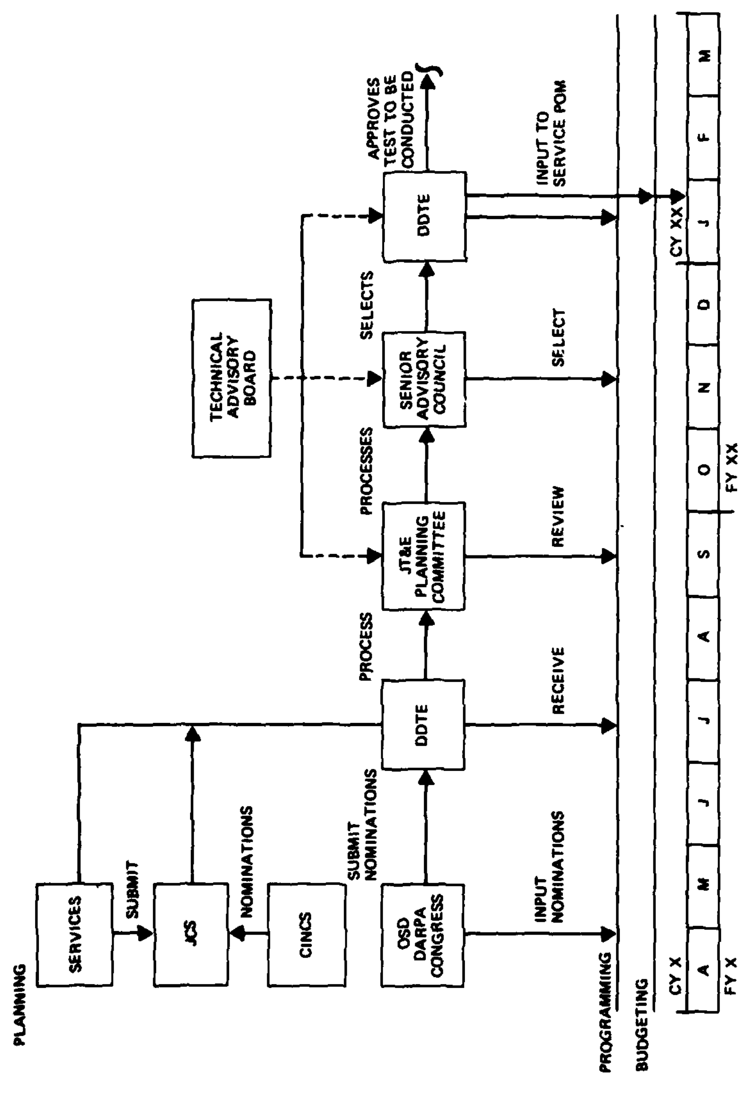
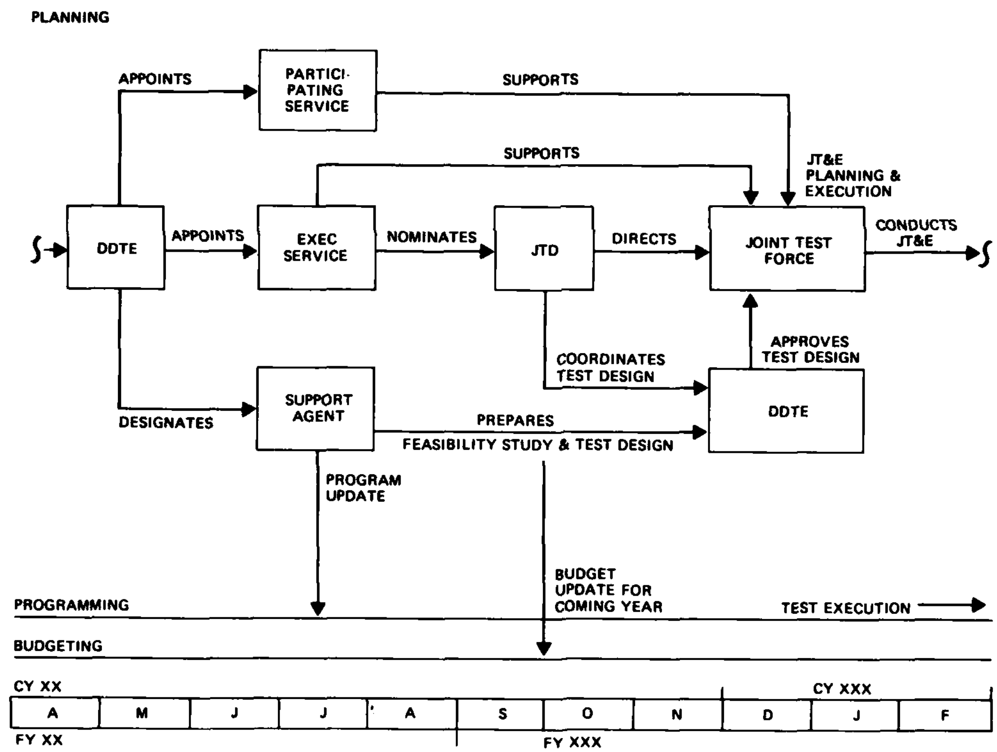


FIGURE 2A
JT&E Planning and Execution



Funding of JT&E

The first joint operational test sponsored was Combat Hunter, the Maverick joint test. This was begun in FY 1972 with RDT&E funds from the Office of the Secretary of Defense, Studies and Analyses. In FY 1973, JT&E funds were allocated under the new appropriation, Director of Test and Evaluation, Defense. OSD established in 1973 a new program element, 65804D, for this appropriation. The funds provided are to be used for costs unique to the needs of a joint test, such as feasibility determinations; test design and planning support; development, procurement, installation, and operation of special instrumentation; transportation, travel, and per diem for test directors' staffs; modification of test articles; and the provision of data collection, reduction, analysis, and test reporting. The services are reimbursed from this appropriation for unique costs incurred as a result of a directed test. The services will not be reimbursed from this appropriation for normal operation and maintenance (O&M) expenditures incurred in support of joint tests. This program element also supports (1) study efforts (instrumentation, measurement of workloads and capacities, computer requirements) for improving the major ranges and test facilities, and (2) T&E independent activities, including independent assessments of T&E directed by either congressional committees or the Secretary of Defense.

From this program element, all of the 26 current, completed, or cancelled joint tests have been funded. To this amount, however, must be added the service O&M costs incurred during these tests. The precise values for O&M are not readily available, but have been estimated as approximately equal to the OSD funding in the aggregate. For some of the less complex tests, O&M costs would undoubtedly have been less, but for more complex tests, service O&M outlays could easily exceed the OSD funding. A summary of PE 65804D JT&E appropriations since FY 1972 is depicted in the funding profile at Figure 3.

FIGURE 3
DDTE JT&E Expenditures (\$ Millions)

FY 72-78	FY 79	FY 80	FY 81
$154	$25	$32	$31

Past Joint Tests and Evaluations

Twenty-six joint tests and evaluations have been initiated since 1971. Fourteen tests have been completed, seven are ongoing, and three have been deferred. Two new tests under study are scheduled to begin in FY 1981, and three addi-

tional tests to begin in FY 1982 have been selected for feasibility study. These tests were initiated as a result of service nomination; to address critical issues of the Congress; as a result of recommendations by the Scientific Advisory Board; or to answer critical issues for DSARC reviews.

The reasons for conducting joint tests can be divided into two categories: (1) to resolve critical issues and problems related to the acquisition of systems; and (2) to establish and validate requirements related to systems, missions, and personnel as they relate to joint combat operations. Most joint tests conducted to date have provided data and analysis concerning capabilities or mission performance of current or developing systems. Information and data have been collected to evaluate technical concepts and to validate and evaluate tactics, joint doctrine, and operational procedures.

In Figure 4, the 17 tests conducted to date are displayed in matrix form to reflect their relationship to the objectives of (1) resolving issues and problems, or (2) establishing and validating requirements. From the figure it is obvious that the objective of most tests conducted thus far has been "Testing System Capability and Effectiveness" to resolve issues and problems. Objectives in the category of "Establishing and Validating System Requirements" have been more varied, with some emphasis on functional mission requirements.

Ten of the tests involved fixed- and/or rotary-wing aircraft; seven addressed issues of close air support. Laser, optical, and infrared seeker capabilities

FIGURE 4
Objectives of Completed Joint Tests

	REASONS FOR JT&E								
	RESOLVE ISSUES/PROBLEMS				ESTABLISH/VALIDATE REQUIREMENTS				
JOINT TEST	COMPETITIVE SELECTION	RELATIVE MERITS	CAPABILITY EFFECTIVENESS	ALTERNATIVE AND RISK	WEAPON SYSTEM RQMTS	SIMULATION MODELS RQMTS	FUNCTIONAL SYSTEM RQMTS	MISSION RQMTS	PERSONNEL RQMTS
MAVERICK			●	●					
ACFT SURVIVE			●			●			
AIRVAL			●		●				
RABVAL					●				
EWJT			●				●	●	
HITVAL						●			
LGW CM			●				●		
SEEKVAL		●			●	●	●		
A 7/A 10 FLY OFF		●	●						
CAS C^3			●				●	●	
LASER GW CAS		●	●				●	●	
AIMVAL		●			●				
LOTS		●	●						
ACEVAL			●		●			●	
EW CAS			●					●	●
I^2R MAVERICK			●	●					
TASVAL			●		●			●	

associated with precision-guided weapons were also tested. The capability of command, control, and communications, and technologies such as data link were prime objectives in four of the tests. The "Logistics Over-the-Shore" JT&E was unique in that it evaluated techniques, equipment, and supply methods and problems associated with logistic support from ships over-the-shore on unprepared beaches.

Emphasis to date has been on aircraft-associated systems. Seventy-five percent of the tests have focused on some aspect of air warfare: air-to-air, air-to-ground, ground-to-air, electronic warfare, and close-air support.

The objectives of ongoing and planned tests are generally capability and effectiveness, functional system requirements, and mission requirements. The emphasis is toward systems, concepts, and technologies rather than hardware. Issues such as the vulnerability of data link, the effectiveness of IFFN, electronic warfare, capabilities, and countermeasures effectiveness on C^3 are the near-term trends. They are tough issues, and operational insights can best be developed from realistic testing in a joint environment.

Results of Joint Test and Evaluation

It is difficult to assess the total impact of a particular joint test since records aren't kept of all the decisions made from the results or all the follow-on analyses which rely upon joint tests for a data base. However, a review of test reports, interviews of participants, and research reveals that there has been utility in most JT&E conducted. The following assessment of JT&E utility is a compilation of several individuals' perceptions of how the test results were or will be used:

ELECTRONIC WARFARE JOINT TEST (EWJT)

EWJT investigated the capabilities of various mixes of U.S. airborne electronic warfare equipment to protect aircraft attacking heavily defended ground interdiction targets. Test results have been used to improve current operational EW equipment employment and to assist in developing new EW systems. Participating aircraft, in the joint test, flew at medium and high altitudes, which led to a follow-on joint test to examine electronic warfare at low altitudes during close-air support—of which more later.

A-7/A-10 FLYOFF

This test was done in response to congressional interest. It was designed, conducted, and results were evaluated in a few months. The results supported the procurement of the A-10. It also showed that joint tests can be done in a "quick reaction" mode. The flyoff was conducted in early 1974 and the DSARC III production decision was held in the fall of 1974.

CLOSE AIR SUPPORT COMMAND AND CONTROL (CAS-C^2)

This JOT&E examined the capabilities and limitations of tactical command and control elements of all the services—especially from the points of view of responsiveness, accuracy, and reliability, when used to provide air support to engaged ground troops. This testing was done over a period of nearly 2 years on a non-interference basis during a series of eight large-scale JCS exercises. Advances in today's instrumentation permit a better collection of data than was experienced in this test. However, requirements for improvements in C^3 procedures and equipment were identified for a variety of close-air-support situations.

SHORT-RANGE AIR-TO-AIR MISSILE JOINT TEST (AIMVAL)

The operational effectiveness of various concepts for a future short-range air-to-air missile was evaluated during AIMVAL. This JT&E was conducted using the Air Force Air Combat Maneuvering Instrumentation (ACMI) range at Nellis AFB. The most important result was to demonstrate (contrary to the expectations of many people) that missile-seeker off-boresight capability of greater than 40 to 45 degrees would provide no additional air combat advantages—that such launches were actually associated with a decrease in lethality compared to those at lesser angles. During the testing, most simulated missile launches were at off-boresight angles of less than 10 degrees, even when much greater capability was available to the aircrews. AIMVAL also demonstrated the utility of two-sided testing; provided valuable training; collected valuable data regarding missile seeker reaction to aircraft IR signatures under adverse IR conditions; and resulted in a joint service operational requirement for ASRAAM. AIMVAL also told us we should not pursue either of the two concepts (the Air Force Claw or Navy Agile).

MULTIPLE AIR-TO-AIR COMBAT JOINT TEST (ACEVAL)

The principal purpose of ACEVAL was to determine how the outcome of close-in, within-visual-range, maneuvering air-to-air combat between aerial forces is affected by the number of aircraft on each side at the start of an engagement. In the interests of efficiency, ACEVAL was done by the same Joint Test Force as AIMVAL, and used the same ACMI. Numbers and force ratios were found to affect the outcome of close-in air-to-air combat. Another major finding was that the pilot became saturated in 4 vs. 4 engagements. He had a difficult time integrating GCI, visual information, and displayed information while trying to fly the aircraft. ACEVAL results pointed out the need to improve our beyond-visual-range capability. As in all major tests of this magnitude, there are different viewpoints; however, the AIMVAL/ACEVAL tests did save the government millions of dollars in procurement, and lives will probably be saved because of

the lessons learned about the weapon deficiencies and tactics for employment. Some other fallouts of the ACEVAL tests included the development of new tactics for air-to-air combat, modification to the avionics of the F-15/F-14 aircraft, and the highlighting of the importance of an improved medium-range capability.

TACTICAL AIRCRAFT EFFECTIVENESS AND SURVIVABILITY IN CLOSE AIR SUPPORT OF ANTI-ARMOR OPERATIONS (TASVAL)

TASVAL was a large joint test conducted at Fort Hunter Liggett, Calif., in August and September 1979. The main objectives of the test were to evaluate the factors affecting the survivability and target-kill effectiveness of AH-1S (Cobra) and A-10 aircraft on typical close-air-support missions against a heavily defended Red attacking armor ground force.

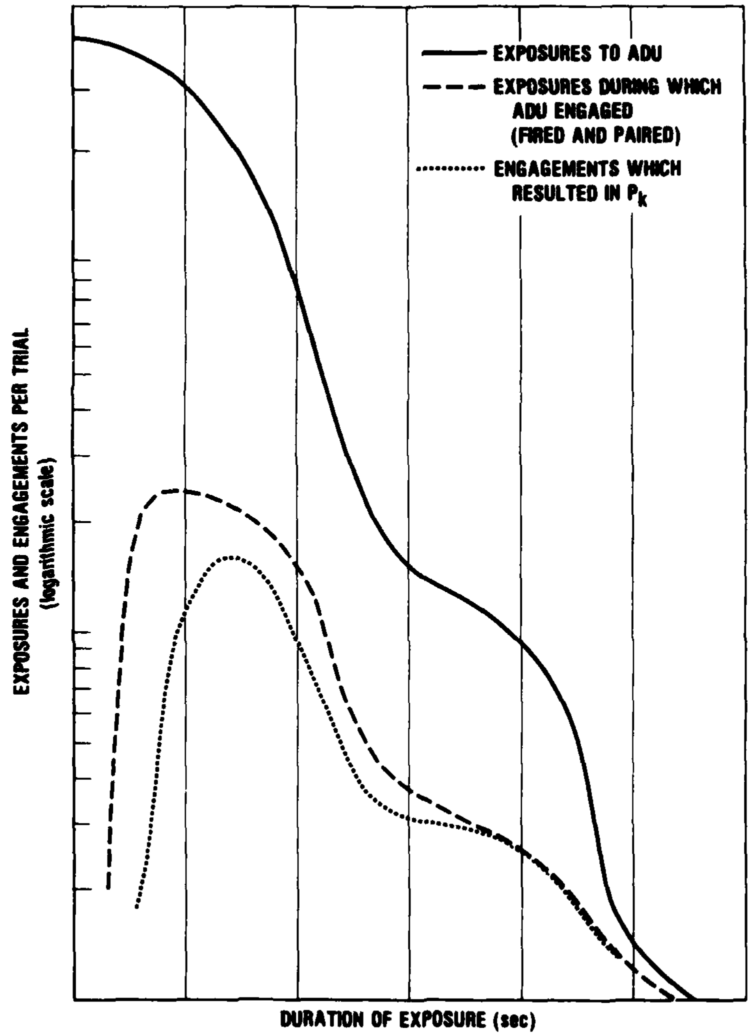
Over 100 Red and Blue players were instrumented to determine position, speed, target pairing, and all pertinent event data vs. time. Near-real-time indication of casualties was furnished to players. Casualty removal was used for all players except aircraft. While there is still a need for improvement in instrumentation capacity, accuracy, and reliability, the TASVAL test was a major first in this type of large two-sided instrumented test. There are many lessons to be learned from the successes and difficulties experienced during the conduct of the TASVAL test.

The quantitative data from TASVAL were derived from computer calculations after trial execution. (Near-real-time casualties were used to shape the battle and for properly motivating the Red and Blue players.) Aircraft air-to-ground target kill effectiveness was derived from probability-of-kill "look-up tables" utilizing player position, pairing, and event data. Aircraft survivability was calculated using missile and gun "fly-out models." Aircraft exposures and engagements were calculated using player position, digital terrain models, and event and pairing data. While the field execution portion of the test took only two months, the calculation, validation, and distribution of the official TASVAL data base has been an 8-month around-the-clock operation, being completed only recently. Analyses are still in progress by the Army, Air Force, and the Institute for Defense Analyses.

We expect the TASVAL results to be extremely useful to DOD. The following are a few examples of the type of data we expect TASVAL to produce.

The TASVAL data base provides a complete time history of the relative positions of all players during each trial in two test sites, Gabilan and Nacimento valleys. These positions-vs.-time plots may be used to examine variations in tactics of Red and Blue players. The flight path histories of helicopters and fixed-wing aircraft are particularly useful to current and future analyses, as they represent a large sampling of aircraft performing typical combat maneuvers.

FIGURE 5
TASVAL Aircraft Exposures to Air Defense Batteries and Air Defense Engagements of Aircraft



The TASVAL data base will support a survivability analysis consisting of three major phases:

(1) Exposure of aircraft to air defense units (ADU).

(2) Engagements of aircaft by ADUs and of ground targets by aircraft.

(3) Estimated P_k resulting from these engagements.

The exposure analysis involves the identification of the number and duration of exposures by aircraft to the various air defense systems in TASVAL. (An exposure is defined to be a time when line of sight exists between the aircraft and ADU.) These exposures can be examined to determine if an engagement vs. the aircraft took place while the aircraft was exposed. A missile fly-out simulation model can then be used to assess the outcome of this engagement. Figure 5 presents an example of this type data.

Additional analyses (not shown in Figure 5) are also feasible using the TASVAL data base. Some of the possibilities are:

—Calculation of the probability of engagement given an exposure.

—Analysis of the number and duration of exposures required by aircraft to deliver their weapons.

—Estimation of reaction times (i.e., time from aircraft unmask to ADU fire) of the various ADUs.

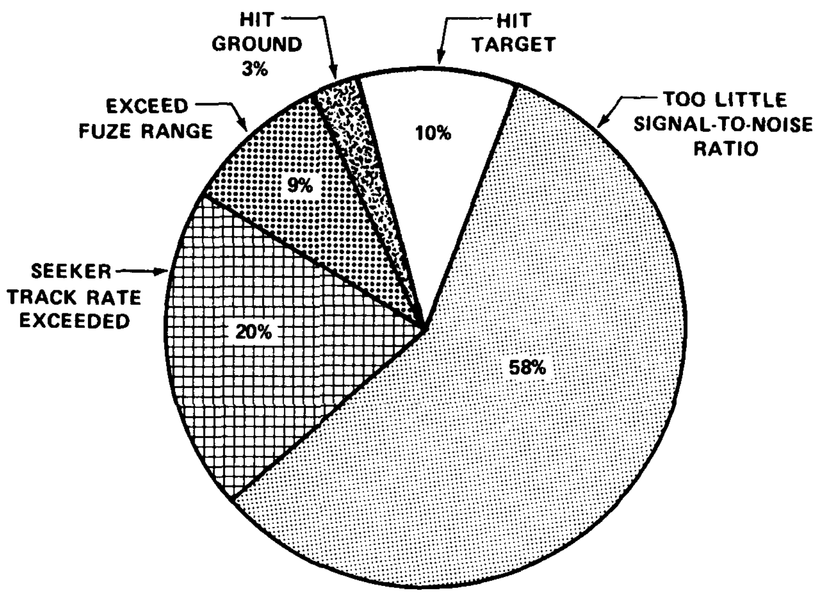
—Analysis of the effect on survivability due to different positionings of air defense units and different aircraft pilots.

The final step in the test analysis is the estimation of probability of kill of the aircraft. This is done primarily by means of a missile fly-out model. A sample of the results of one such model used in TASVAL is presented in Figure 6, which shows the outcome of a sample of engagements by an air defense missile against an aircraft. In this sample, 10 percent of the missile firings hit the target and therefore resulted in a P_k. The other 90 percent of engagements "missed"; the reasons for the missile not hitting the target are presented.

ELECTRONIC WARFARE IN CLOSE AIR SUPPORT (EW/CAS)

EW/CAS is a large-scale joint test and evaluation designed to evaluate the effectiveness of airborne electronic warfare equipment and the tactics and techniques for using it against a realistic threat during close-air-support (CAS) operations. Fundamental to the success of the JT&E is the development of an accurate representation of a potential enemy threat array instrumented sufficiently to obtain quantitative and qualitative data on the outcome of a many-on-many battle. Creating the EW/CAS test environment has been a major task involving significant effort by the service intelligence and development agencies as well as the Defense Intelligence Agency, the National Security Agency, and industry.

FIGURE 6
Example of TASVAL Results of Engagements by Air Defense Unit of Aircraft



The threat array represents the air defense and REC assets of a 10-by-40-kilometer slice of a potential enemy motorized rifle division in a breakthrough scenario. Approximately 100 threat components are simulated to provide communications intercepts and jamming, surface-to-air missile and anti-aircraft systems, acquisition and height-finder radars, and extensive command and control elements to replicate the environment as accurately as our intelligence permits. The goal is to understand the synergistic effects of a force-on-force confrontation; to gain insights on which mixes of electronic warfare equipments and tactics work best against a heavily armed and sophisticated enemy. Because the scope is so broad, we have taken a somewhat different approach to this test. In order to reduce equipment and manpower resources and to apply a building-

block philosophy to the test methodology, EW/CAS has evolved into a two-phase, incremental test taking advantage of scheduled service exercises or training activities where possible.

Phase I, called the tactical communications jamming (TCJ) phase, was completed in March of this year. Phase I was conducted in six increments. The first three increments consisted primarily of gathering engineering data on the effectiveness of the simulated communications jammers in an operational environment. Separate tests were conducted to evaluate jamming in the UHF, VHF, and HF bands; the services were provided data to show where and when communications were possible in each band and gained insights into certain limitations of the jamming systems. The test force was also able to evaluate and refine instrumentation and data collection and analysis schemes for the subsequent more complex increments. Examples of the type of data derived from these initial tests are shown on Figures 7, 8, and 9.

FIGURE 7
EW/CAS Test Results of Intra-Flight UHF Communication Capability Under Jamming Conditions

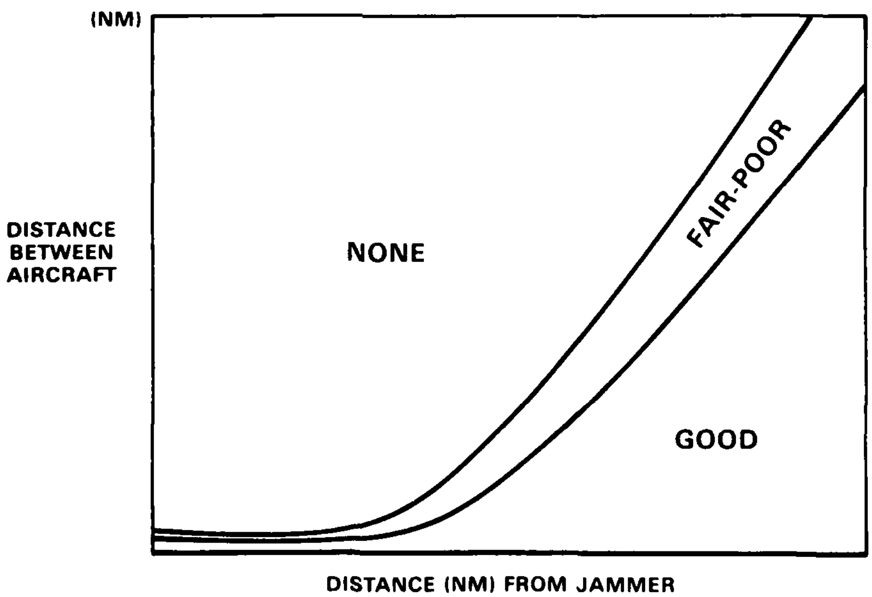


FIGURE 8
Ground-Ground
VHF Communications Capability

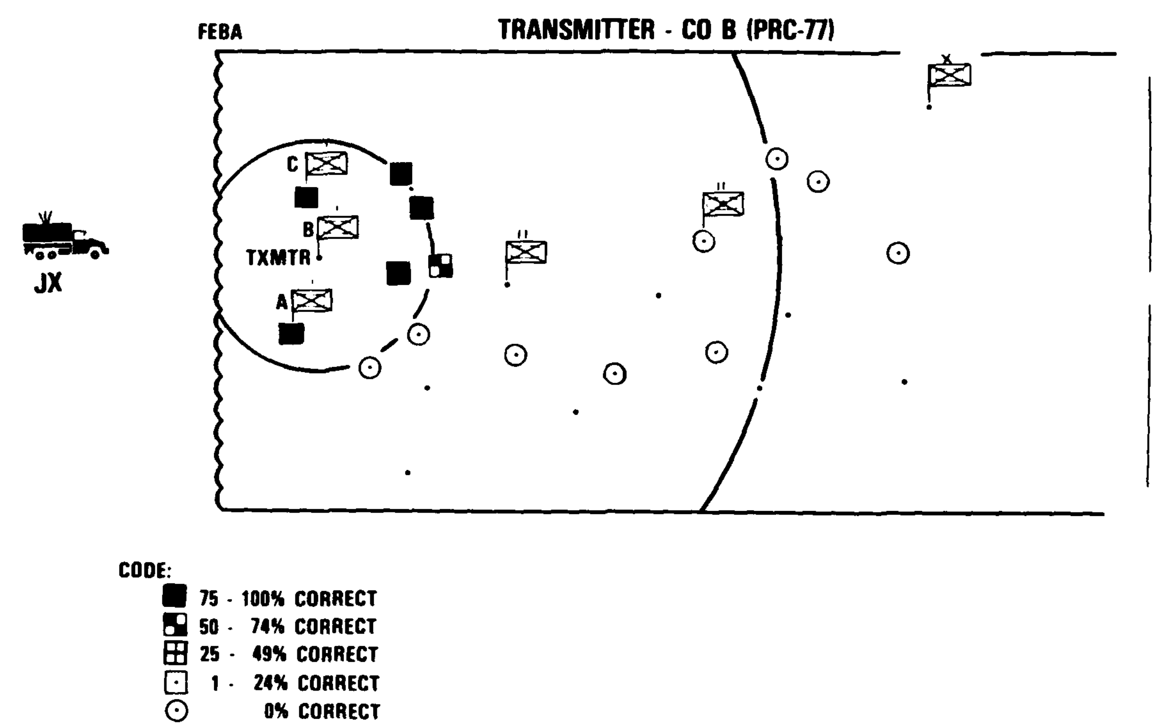
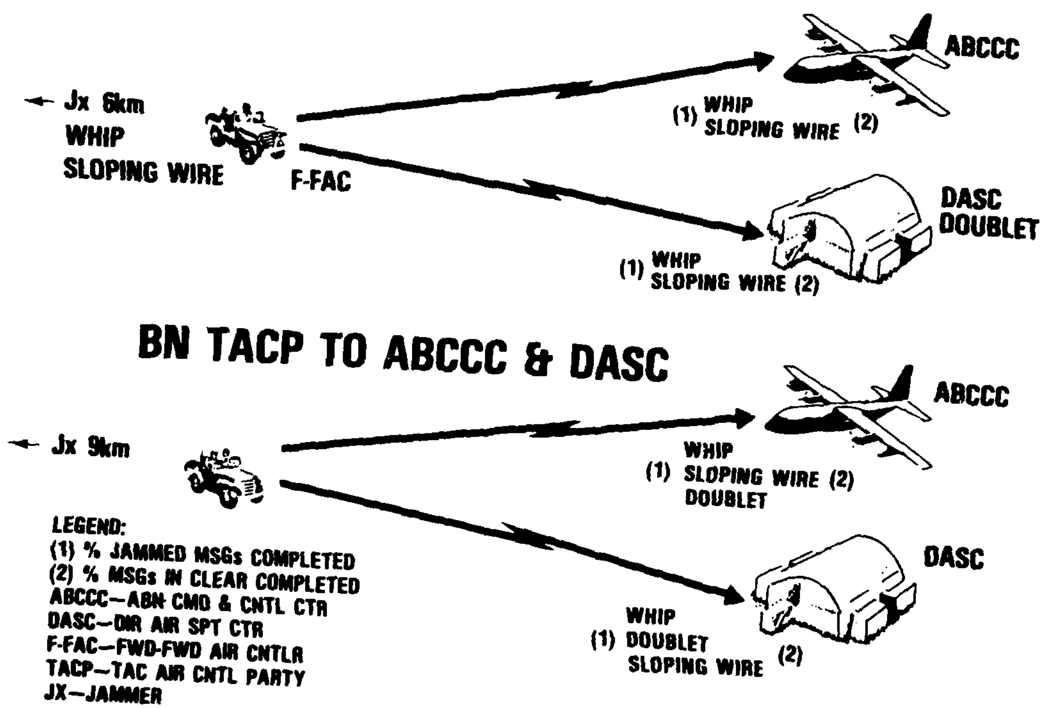


FIGURE 9
CAS Request NET HF
Communications Capability



Test increment four introduced the intercept and identification portion of the postulated enemy radio-electronic combat system and included jamming simulators in each of the communications bands. Friendly forces were played in a close-air-support scenario involving live air strikes against realistic tactical targets. The entire close-air-support request and execution communications nets were targeted by the simulated threat anti-communications system. In addition to gathering hard data regarding the effectiveness of U.S. electronic counter-countermeasures, the service participants, who were from combat-ready field units, gained valuable training by operating against the most realistic communications-jamming threat available.

Test increment five, entitled the combined arms test, followed the building-block approach of increasing complexity and more ambitious goals. The total simulated enemy non-lethal radio-electronic combat system was fielded along with the simulated forces of a motorized rifle division. Friendly forces were represented by a brigade slice of a U.S. Infantry Division (Mechanized) supported by the Air Force Tactical Air Control System, live close-air-support aircraft and attack-helicopter elements. Test five enabled us to evaluate the effects of jamming on the total battle conduct rather than just selected communications nodes. We were able to place commanders under stress and they were required to continue the battle even when they were denied all the communications they desired. Communications jamming, of course, does not stop a combat operation, nor is it the decisive element on the battlefield, but it does cause delays and confusion that can have a significant domino effect through the command structure. Since test five gathered fairly precise data on attrition as well as maneuver force movements, important information was gained regarding the severity of the jamming threat. As in previous test increments, a significant side benefit was the realistic training provided to the test participants and the opportunity for them to experiment with tactics to defeat the threat.

The communications-jamming phase of EW/CAS culminated with participation in the major joint readiness exercise, Gallant Eagle 80, conducted at Fort Irwin, Calif., last March. Gallant Eagle 80 was a field exercise involving four ground-maneuver battalions in each of the Red and Blue forces and the most Air Force, Marine, and Army air assets involved in a single operation for many years. Over 25,000 personnel were directly involved in the exercise.

Even with the limitations imposed by the free-play scenario, there was very good data correlation with previous test increments. As in test five, the contribution of communications jamming had a definite, if not decisive, impact on the outcome of the battle. In test six the effect of jamming was much harder to quantify, but the delays, confusion, and lack of timely information reported by the

Blue commanders revealed important insights into what U.S. forces can expect if faced with this type of threat. An interesting and important observation of the test force involves the perceptions of the senior commanders—the further the command node was from the engaged forces, the less it appeared that jamming was a problem. This is because the jammers, particularly those targeted against VHF ground nodes, have limited range and are therefore most effective against the troops in contact who are most dependent on timely communications. The senior commanders, while very aware that things were not going well, seldom attributed the problems to jamming and did not take action to remove the threat. Again the training benefits afforded the exercise participants were a valuable fallout of the test.

Phase II of EW/CAS, the air support operations (ASO) phase, will introduce the air defense simulators and tie together the entire threat array mentioned earlier. The ASO test will be conducted on the Nellis AFB range complex and will also follow the incremental approach used in Phase I. Extensive pre-test preparations are underway to evaluate the new simulators, check out instrumentation, and develop the software data collection and analysis schemes. The ASO phase is more ambitious and complex than Phase I, but we are confident that by continuing the systematic, incremental approach, we will obtain detailed information that will be vital to the operational forces.

The foregoing has attempted to highlight the types of results expected from joint testing. JT&E has provided empirical data, gathered under realistic conditions, to address critical questions regarding future weapons and the combined tactical employment of weapon systems. JT&E is the best method for addressing conceptual issues which involve more than one service. There have been important and valuable spin-off results such as the identification of the need for combined force tactics, needed modifications of current weapon systems, and the identification of training requirements. JT&E participants have gained knowledge and skills that generally were previously acquired only in combat. Test results provided inputs to the decision to proceed with the preparation of much-needed weapons such as the EO and IIR Maverick. Competition between the A-7 and A-10 was resolved. The requirements for critical modification to aircraft and EW systems were revealed during JT&Es. Significant training benefits were a major fallout from better than 60 percent of the tests. With an improved nomination and selection process we can look forward to even more worthwhile joint tests in the future. They have been and will continue to be an important means of judging our ability to conduct combat operations with current and future weapon systems.

Methodology and the Future of JT&E

The process of joint test and evaluation has produced empirical data and information which, when added to the total repository of data available, represents an immeasurable contribution to decision-making, planning, and doctrinal change. Considerable advancements have taken place in JT&E through a continual effort by the elements involved. They have analyzed JT&E methodologies and results with a view toward improving the organization, planning, and methodology with the goal of producing a totally useful product.

In addition to sponsoring specific joint tests, the DDTE has from the beginning had a responsibility to improve the methods and facilities for performing operational test and evaluation. In other words, we are charged with improving the quality of joint testing. Over the years, this has involved procuring and upgrading test-range instrumentation, and developing and procuring threat simulators to enhance test realism. The most widely known DDTE initiative with regard to instrumentation is that of providing the means to obtain the time-space position information (TSPI) that is needed for virtually all joint tests. One of DDTE's first actions was to procure a transportable version of the range-measurement system/simulated combat operation range equipment (RMS/SCORE), as the DDTE's system is called, was first used for the Maverick two-sided test at Fort Riley in 1972, and since then has been in almost constant use. For example: A-7/A-10 fly-off, the electronic warfare joint test, TASVAL, and it is currently being installed on the Nellis Air Force Range for EW/CAS.

We continue to improve our capabilities for supporting joint tests as an integral part of the test design process. The RMS/SCORE system has been upgraded continuously to meet the needs of joint tests and represents a state-of-the-art TSPI system which has significantly changed from the one used for the Combat Hunter Maverick test. With some further improvements in accuracy and capacity, already programmed, it will continue to be our basic TSPI system for at least most of the 1980s.

DDTE has also funded threat simulators, most recently for EW/CAS. When the joint test is conducted at Nellis next year, the threat environment will include DDTE-funded simulators for the Soviet SA-4 and SA-8 ground-to-air missile systems, for some associated radars, and for some ground-based jammers. These systems will have a common data interface for integration with other already established instrumentation at Nellis.

The advance in instrumentation for joint tests most desired by the OT&E community would be a capability for real-time (or at least near-real-time) casualty assessment and prompt removal from the test arena of players assessed as casualties. This has been one of our goals for a long time, and while it involves

very difficult technical problems, I am reasonably confident that we will achieve it within several years.

There has been steady improvement in test methodology, instrumentation, and data management beginning with the first JT&E in 1972. Maverick was the first two-sided test using Blue Maverick equipped aircraft against Red armor vehicles. The lessons of JTF-2 were used effectively and resulted in the improvement of data management and analysis and the development of time-tagged graphic records of events. Timelines have proved to be a useful and adaptable method for providing quick diagnosis of timing and other problems associated with data collection, reduction, validation, and analysis.

Air Combat Evaluation/Air-to-Air Intercept Missile Evaluation (ACEVAL/AIMVAL), using the air combat maneuvering instrumentation (ACMI) system, provided an advanced instrumentation- and data-management system for conducting real-time testing in a simulated combat environment. The computerized data-management system permitted acquisition of test data from the ACMI, aircrew debriefings, test controllers, ground monitors, and meteorological and maintenance facilities. It provided an event-oriented, on-line data base. Interface software was developed to extract data for statistical processing and quick summary analysis. The data-management software now serves as a generic model for future air-to-air data-management systems.

Over the past 9 years what has emerged is a fusion of the analytical and statistical aspects with operational realities. The two joint tests which demonstrate the dramatic advancements in testing are TASVAL and EW/CAS.

The ongoing EW/CAS joint test illustrates some of these advancements. Sophisticated instrumentation now facilitates the rapid on-site processing of large amounts of data and the development of a many-faceted training program for the fast and effective training of large numbers of data-collection and processing personnel.

The design of the data-management system for EW/CAS called for the use of minicomputers small enough to transport from one test site to another, and larger minicomputers housed in a central facility linked to the test sites via multiplexed communications. This technique has broad application, particularly to the collection of data during large-scale maneuvers without the generation of large-scale support requirements in remote areas.

Microprocessors known as electronic clipboards (ECBs) were also developed for and used during the EW/CAS tests. The ECB is a time-tagged event recorder with a 16-kilobyte memory and a self-contained power supply. At the end of a data-collection period, the ECB is returned to a processing facility where the information stored in it is dumped directly into a computer. The data is then com-

bined with that from other sources to provide an overall picture of the battle. It has set the stage for a quantum leap in the area of hand-held data-collection devices. The ECBs represent use of the tremendous capability of microprocessors and moves toward distributive processing.

Every attempt was made during EW/CAS testing to scope the test to minimize the impact on normal operations and the burden placed on the services. Thus, at communications nodes where data was to be collected, dedicated data collectors relieved the operations of this burden.

TASVAL initiated the concept of the dynamic air-ground battlefield and EW/CAS has produced a mature, integrated air-defense system so realistic it has wide ramification for training as well as testing. EW/CAS has provided a complete system rather than just individual simulators. Communications, control procedures, and operational concepts all reflect enemy doctrine.

As in the case of EW/CAS, TASVAL represents a significant evolutionary step in operational test methodology and instrumentation. In TASVAL, a total of over 100 armor vehicles, air-defense systems, and A-10 and AH-1S attack helicopters were fully instrumented. This instrumentation continuously determined the location of each weapon system and also recorded discrete event data from each system. In addition, each weapon system was instrumented with a laser-sensor system which permitted the simulation of engagements between opposing weapon systems. By connecting this instrumentation to a central computer, it was possible to assess in near real time the casualties from all engagements except those by the air-defense system. The current state of testing methodology does not permit assessment in real time of air-defense engagements due to the size and complexity of computer models of air-defense systems. Studies are underway to define improved methods of real-time casualty assessment (RTCA). Although this was not the first test to use RTCA methodology, it was several times larger than any previous test conducted.

A large number of new instrumentation components were designed and fabricated to ensure the realiable collection of all required data. Among these components were microprocessors mounted on each of the player vehicles. The introduction of the microprocessor represents a major advancement in instrumentation for joint tests and a step towards decentralization—a direction that instrumentation, like many other technologies, is taking. The microprocessors controlled all the instrumentation components on each player, preprocessed the data before telemetering it to the central computer, and built-in software routines permitted on-board test and diagnostics of the instrumentation. An additional major advantage of the microprocessor is increased flexibility: changes can be made by software modification rather than hardware fabrication.

Sophisticated analytic methodologies were also developed to combine information from three separate instrumentation components—RMSB units, SCORE pods, and radar altimeters—in order to obtain the best estimate of aircraft flight path. It took the combination of all three instrumentation components to provide an acceptable measure of aircraft altitude throughout the flight path.

The net result of these advancements in instrumentation and methodology was a significant improvement in the detail and quality of test data. It is now possible to produce map plots and overlays which provide visual representation for post-trial analysis. Approach routes of various combat elements can be plotted in time, location, and direction. The relationship of Blue vs. Red can be visually observed. As a result of accurate position location and data smoothing, it is possible to plot aircraft flight path, altitude, weapon launch points, and breakaway. Overlaying the air-defense plots makes it possible to fix air-defense weapon engagements and target engagement made by the Blue forces. The information combines the aircraft traces, target engagements, and air-defense weapons engagement in time intervals. This permits visual representation of interactions of all players and provides a valuable post-trial and data-validation capability.

Future requirements for joint tests are for larger, more complex tests of concepts and technology. Tests under consideration include: data-link vulnerability to determine the vulnerability to jamming of tactical data links used to control weapons and C^2 systems; forward-area air defense, to determine effectiveness of integrated forward-area air-defense systems against low-altitude hostile aircraft threats; battlefield airspace control, to evaluate the effectiveness of various proposed doctrine for airspace management and control; identification of friend, foe, or neutral, to evaluate the operational effectiveness of systems and procedures for discriminating between friends, enemies, and neutrals. These tests are planned for near-term execution. In addition, there are command, control, communications, and intelligence-gathering systems in various stages of research and development that must be tested in a joint environment to determine required interoperability.

The complexity of the planned and possible future joint tests will present greater challenges; however, our ability to conduct such tests is greater by a factor of 10 as compared to our abilities in 1972. Instrumentation systems are more responsive, more flexible, and can accurately measure many parameters. Statistically sound data collection, reduction, and analysis have been fuzed with operational realities. The military, government, and private industry now have a solid base of personnel who are skilled in testing and test techniques. These people are developing better procedures and methodologies and have an extensive background in operational doctrine, requirements, and procedures. Management

and organization have been formalized and improved to eliminate the problems of the past.

Joint test and evaluation has become a mature process. It has continued to grow and advance to provide an extremely effective vehicle to assure a strong military force that is ready for combat and equipped with proven weapon systems and supporting systems to carry out their respective missions.

A Management Approach to the 80s

84

Major Wallace B. Frank, Jr., USAF

For years, the U.S. intelligence community has charted the ever-increasing Soviet capability to wage all types of warfare. The Soviet incursion into Afghanistan was a grim reminder of Soviet intentions to use this capability. The implication for U.S. forces is a growing list of requirements that must be satisfied with limited resources. Lawrence J. Korb concludes his comprehensive review of the defense program for fiscal years 1980-84 with this comment:

> Rhetoric aside, the FY 1980 budget (like the FY 1979 budget) is at best a level one. Compared with the program laid down a year ago it will call for less, in both an absolute and relative sense.[1]

At this writing, the vote is still out on the current round of rhetoric. This paper examines a new management approach based on the effective use of mission-area analysis, a concept designed to help Air Force leaders cope with the challenges of increasing requirements and limited resources.

A review of mission-area analysis in the current management structure is a prerequisite for understanding this new approach. Therefore, I begin this discussion with a brief description of the environment for mission-area analysis, trace its history, outline the current operating methods, and analyze its latest use in the Air Force Systems Command's "Vanguard" management process. Finally, I discuss a new management approach based on the concept of mission-area analysis.

The Defense Management Environment

Mission-area analysis operates in two related defense management processes: the planning, programming, and budgeting system; and the systems acquisition process. As the formal resource allocation process used throughout the Department of Defense, the planning, programming, and budgeting system provides an "integrated system for the establishment, maintenance, and revision of the Five Year Defense Program and the Department of Defense budget."[2] Although this

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1. Lawrence J. Korb, "The FY 1980-84 Defense Program: Issues and Trends," *AEI Foreign Policy and Defense Review*, I:4, p.53.
2. "The Planning, Programming and Budgeting System," *DOD Instruction 7045.7*, 28 October 1969, p.4.

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discussion focuses on the programming and budgeting phases, you must understand that the ultimate goal of a management approach based on mission-area analysis is to build a bridge between the Air Force mission (the objectives of military action) and the future forces required to accomplish that mission. The planning, programming, and budgeting system provides three major products on an annual basis: the program objective memorandum (POM), the budget estimate submission, and the President's budget.

The program objective memorandum is the initial submission to the Department of Defense. It contains recommendations for a 5-year program to satisfy mission requirements to the degree possible with Department of Defense fiscal guidance. Zero-base budgeting notwithstanding, the program objective memorandum has remained an incremental, albeit comprehensive, change to the most current 5-year defense program. The budget estimate submission (the second service submission to the Department of Defense) updates the program objective memorandum to reflect changes in mission requirements, the latest status and prices of various programs, and Department of Defense decisions regarding service recommendations. The President's budget concludes the process and reflects the executive branch's request to Congress for program authorization and appropriation.

Traditionally, the director of programs, who has functional responsibility within the Air Staff to develop the program objective memorandum, has elected to involve the Air Force Board Structure in the preparation of these products to ensure representation of all facets of the Air Force throughout the allocation process. The panels of the Air Staff board assess the appropriate funding level for the programs within their purview, and forward their recommendations to the Program Review Committee. This committee integrates these recommendations into a total Air Force program, and identifies issues for resolution by the Air Staff Board and the Air Force Council. Ultimately, the council recommends a total program to the Chief of Staff and, in turn, to the Secretary of the Air Force.

The systems acquisition process brings new capabilities to fruition as efficiently as possible while the planning, programming, and budgeting process distributes resources among competing requirements. AFM 1-1, "Functions and Basic Doctrine of the United States Air Force," describes the tenets of this important process as follows:

—Maintain superiority in basic research and enrich the technology base;
—Identify new systems and system improvements that meet the near and long-term needs of aerospace forces;
—Respond quickly to a crisis-induced need for equipment or material;
—Examine the relative cost and effectiveness of various war-fighting systems;
—Identify required operational capabilities/needs;

—Discover new and alternate resources to replace resources that may not be available;
—Contract for, and acquire, systems, goods, and services efficiently and effectively.[3]

The philosophy adopted by the Air Force to achieve these ambitious goals is expressed best in the approach set forth in Department of Defense Directive 5000.1, "Major Systems Acquisitions." The approach is phased with measured decision points designed to reduce technical risk and avoid premature commitment of resources. Identification and validation of a need leads to consideration of various system concepts. The most promising concepts are selected for demonstration and validation through the use of engineering prototypes. The best concepts are chosen for full-scale development and testing. Finally, if all goes well, the decision is made to produce and deploy the system.[4]

This fundamental approach led to development of government-wide standards described in the Office of Management and Budget Circular A-109 published in April 1976. The major thrust of A-109 is based on the following concepts:
—Top-level management attention to mission goals and needs;
—A systematic approach to managing mission needs, budgeting, contracting, and program management;
—An integrated approach for reconciling research and development with mission needs and goals;
—Avoidance of premature commitment to full-scale development and production.[5]

The concept of satisfying mission needs underlies both aspects of the defense management environment in which mission-area analysis operates—the planning, programming and budgeting system, and the systems acquisition process. Additionally, the two processes are related in that programs compete for funds with other activities and programs within the planning, programming, and budgeting systems. These interrelationships cause extensive overlapping and frequent conflict. One cause of conflict is that the complexity of a business as large and diverse as national defense makes it difficult to pin down the value of one effort in relation to the value of another. Another cause is that the long lead time required to establish a capability in a particular facet of national defense makes it

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3. AFM 1-1, *Functions and Basic Doctrine of the United Stated Air Force*, Washington, D.C., February 1979, pp. 4-11, 4-12.
4. DOD 5000.2, *Major Systems Acquisition Process*, Washington, D.C., 18 January 1978.
5. "Major Systems Acquisition," Office of Federal Procurement Policy Pamphlet No. 1, August 1976, p. 4.

difficult to predict exact needs 10 to 20 years hence. Rapid technological change exacerbates this problem by making today's engineering solutions obsolete before they can be implemented and producing a constantly changing enemy threat. A final cause of conflict is the political or bargaining nature of the decision process in a large organization like the Department of Defense that often clouds the distinction between needs and wants and leads to illogical compromise.

Despite these problems, the planning, programming and budgeting system and the system acquisition process are built on a common-sense foundation that permits the purchase of essential items before money is spent on items that would be "nice to have." This common-sense foundation is clearly reflected in the micro aspects of both processes, but two factors often obscure the logic at the micro level. First, the frame of reference changes as one proceeds through the steps of each process. For example, threat assessment and planning involve a regional map of the world. Programming is largely functional in nature—bombers, fighters, radars, computers, etc. Budgeting involves classes of expenditures—operations, personnel, production, research and development, etc. The mental contortions necessary to maintain consistency through this maze are difficult at best, and often are impossible. The second factor is the complex interrelationship among individual programs. The very largest defense programs are self-contained, but most programs are intertwined with other existing or planned programs. Thus, many programs require the output of projects within other tiers of programs.

Many of these difficulties have been recognized for a number of years, and efforts to resolve them have followed various approaches. In the next section, I trace the history of one class of solutions, based on mission-area analysis.

History of Mission-Area Analysis

A comprehensive history of mission-area analysis would undoubtedly begin with the record of man's first decision. The only intent here, however, is to look back over some 15 years and trace the direct antecedents of the current Air Force approach to mission-area analysis. The lessons drawn from this review provide the impetus for a new approach to resource management.

In the late 1960s, the director of operational requirements at Headquarters USAF undertook an internal requirements/budget study in an attempt to tie resource allocations to mission needs. He used a straightforward approach that embodied the familiar scientific method:

—Establish mission areas;
—Identify measure of effectiveness;
—Determine mission area effectiveness of currently programmed systems;

—Identify programs and projects to satisfy needs;
—Estimate budget constraints; and
—Structure research and development effort for maximum force effectiveness within available budget.[6]

Although this effort paved the way for subsequent models based on mission analysis, the process was not institutionalized because it had no apparent effect on the actual allocation of budget dollars. This problem is not unique to mission-area analysis; it is characteristic of any complicated process with multiple players. Nonetheless, when the opposing efforts of various players in a process give special emphasis to one or another of the decision parameters, they tend to produce a fairly balanced, rational result.

Forces external to the Air Force were moving in a similar direction. In 1972, the Commission on Government Procurement concluded a lengthy study with a recommendation that Congress adopt a mission approach to its budget review.[7] This recommendation apparently had a direct impact on subsequent congressional action because the Congressional Budget and Impoundment Control Act of 1974 requires each agency to display its budget request along mission lines. More specifically, it contains the following direction:

> The budget transmitted . . . each fiscal year, beginning with the fiscal year ending September 30, 1979, shall contain a presentation of budget authority, proposed budget authority, outlays, proposed outlays, and descriptive information in terms of
> (1) a detailed structure of national needs which shall be used to reference all agency missions and programs;
> (2) agency missions; and
> (3) basic programs.
> To the extent practicable, each agency shall furnish information in support of its budget requests in accordance with its assigned missions in terms of Federal functions and subfunctions, including mission responsibilities of component organizations, and shall relate its programs to agency missions.[8]

After long and prolonged negotiations led by the OASD comptroller, the Department of Defense complied with this requirement and prepared a mission

6. "AF/RDQ Development Planning Study—Budget Position," AF/RDQP, HQ USAF, 22 July 1969, p. 1.
7. "Acquisition of Major Systems," Part C, *Report of the Commission on Government Procurement*, Vol 2, December 1972, p. 78.
8. "Congressional Budget and Impoundment Control Act of 1974," Public Law 93-344, 93rd Congress, 12 July 1974.

display, along with the standard descriptive material, for submission in its budget request for FY 1979. However, this action did not signal a change toward mission-area analysis in the Department of Defense management approach. The process of making resource allocation decisions had not changed; the mission display was merely another way of communicating the results of the existing process. This organizational inertia exemplifies the difficulty in creating change in complex organizations. In the first place, the only committee to move away from the more traditional appropriations categories and strongly embrace mission categories in the budget review process was the new Senate Budget Committee, which had been chartered in the 1974 act. Second, to ensure conformity of Department of Defense expenditures with the requirements of congressional authorization and appropriation acts, the OASD(C) staff maintained its organizational structure, which matches the traditional appropriation categories. The objectives of the director of operational requirements initiative in the late 1960s were still unrealized.

During this period of heightened awareness of mission-area analysis outside the Air Force, another effort emerged within the Air Force. In 1976, the Chief of Staff's systems and resources management action group proposed implementation of a concept called "integrated mission area analysis" as ". . . a method to arrive at alternative forces, acquisition strategies, and RDT&E options that can be logically linked and aligned for presentation to decision-makers in a disciplined, systematic fashion."[9] Integrated mission-area analysis required defining and adopting a common set of mission areas, aligning resources within mission-area categories, and performing in-depth analyses within and across mission areas. The Vice Chief of Staff approved an implementation plan calling for incremental application of this concept to the complex process used to allocate resources. This action sparked the genesis of current mission analysis efforts across the Air Staff, but it did not result in immediate success.

In mid-1976, the Deputy Chief of Staff for Research and Development directed another internal effort to implement mission-area analysis. He defined a set of mission areas, and assigned responsibility to key individuals to analyze each area and advise decision-makers on the best allocation of resources. Like its predecessors, this effort had little impact on the budget because it was not an integral part of the decision-making process.[10] This failure probably would have

9. "Integrated Mission Area Analysis," Management Proposal No. 4, *Systems and Resources Management Action Group*, HQ USAF, January 1976, pp. 4-7, 4-8.

10. Ronald C. Allen (Colonel, USAFR), "An Evaluation of Mission Area Analysis Within DCS/RD," End of Reserve Tour Report, 18 March 1977.

ended the move toward a process based on mission analysis were it not for two important external pressures.

In 1977, the General Accounting Office urged a mission approach that would give Congress a coherent picture of agency needs rather than a great mass of confusing detail.[11] Also in 1977, the infusion of zero-based concepts in the federal budget process called for prioritizing agency budget requests on the basis of needs. In his tasking memorandum to division heads in the executive branch, President Carter noted that zero-base budgeting would "focus the budget process on a comprehensive analysis of objectives and needs."[12] These events led to a final attempt by members of the Air Staff to institutionalize mission-area analysis.

This final attempt began with implementation of a prototype process under the Deputy Chief of Staff for Research and Development during the preparation of the President's budget for fiscal year 1979. The most significant difference between this effort and previous attempts was the complete reorientation of the budget process around the mission-area analysis concept to ensure its impact on the final resource decisions. More than any other single factor, this reorientation contributed to the success of the mission-area analysis concept. Analytically, the concept was much the same as its predecessors; only the process that tied the analysis to the budget was new.

The prototype process included three phases: mission-area analysis to define the need for weapon system improvement, development planning to examine alternatives, and zero-base programming/budgeting to select affordable investment strategies. Each phase was further broken down as follows:

—Mission-area analysis
  —Build a framework of mission tasks and conditions;
  —Identify deficiencies in the context of the relevant threat;
  —Assess the need to improve capability.
—Development planning
  —Identify workable program alternatives;
  —Assess contribution of alternatives to satisfying deficiencies;
  —Build possible development strategies.
—Zero-base programming/budgeting
  —Group programs into decision units;
  —Formulate mission-area investment strategies;

11. "Mission Budgeting: Discussion and Illustration of the Concept in R&D Programs," General Accounting Office Report PSAD-77-124, 27 July 1977.

12. Office of Management and Budget Memorandum for the Heads of Executive Departments and Agencies, "Zero-Base Budgeting," Bulletin No 77-9. 19 April 1977.

—Integrate the research and development program into the total Air Force program.

On 7 September 1977, General Alton D. Slay, then Deputy Chief of Staff for Research and Development, briefed this approach to the Deputy Chiefs of Staff, recommending that the Deputy Chief of Staff, Plans and Operations, take the lead in applying the process Air Force-wide. Its demonstrated success within the research and development community, and its potential for improving allocation of Air Force resources secured adoption of the recommendation.

The Current Approach to Mission-Area Analysis

A memorandum of understanding among the deputy chiefs of staff at Headquarters USAF established the philosophy underlying the broadened application of mission-area analysis and the foundation for the current approach. This memorandum stated that the goal was to "provide a visible and traceable analytic thread from capabilty needs to the enacted Air Force budget."[13] To achieve this goal, it preserved the three-part structure validated by the Deputy Chief of Staff for Research and Development prototype: (a) mission-area analysis under the direction of the Deputy Chief of Staff, Plans and Operations, (b) functional planning accomplished by the cognizant staff element, and (c) mission-area programming and budgeting under the direction of the Deputy Chief of Staff, Programs and Resources, and the Comptroller, respectively.

The plans and operations charter was broad and demanding—make mission analysis work, starting with the preparation of the program objective memorandum for fiscal years 1980-84. To do this, they expanded and improved the methodology used for the prototype. Basically, they had to provide a framework that would (a) define the complete Air Force mission in terms of mission areas and elements; (b) provide a level of discrete tasks/functions with identifiable objective criteria for measuring success; (c) define the conditions and scenarios under which the tasks/functions must be accomplished; and (d) ascribe weighting factors to each task/function and condition.

This framework was structured as a hierarchical branching network, and was automated to allow efficient storage, retrieval, and updating. They used this framework to make comprehensive and detailed capability assessments. These assessments described current Air Force mission capability against the projected threat in specified future time frames, and indicated the relative priority of main-

13. "Memorandum of Understanding on Air Staff Approach to Mission Area Planning, Programming and Budgeting," HQ USAF, 19 September 1977.

taining or improving mission capability. The plans and operations charter also implied that mission-area analysis should be consistent with the demands of the new need-based acquisition process set forth in OMB Circular A-109, as well as with the demands of zero-base budgeting; and that mission-area analysis must encompass the views of all Air Staff agencies and the major operating commands.

Despite the scope and complexity of this charter, and a scant three months until the start of the program objective memorandum cycle for fiscal years 1980-84, they made significant progress. In December 1977, the Deputy Chief of Staff, Plans and Operations, issued the first *Air Force Planning Guide* documenting the results of the expanded mission-area analysis. Although lacking in some areas, it was a superb effort that provided at least a broad basis for allocating scarce resources among competing operational and modernization needs. By building on this base, the Air Staff progressed significantly during 1978 in preparing the program objective memoranda for fiscal years 1981-85. Their progress was clearly evident in the Headquarters USAF report to the Assistant Secretary of the Air Force for Financial Management:

(a) The *Air Force Planning Guide* was published on 15 November 1978.

(b) The *Guide* was briefed to panels and committees of the Air Staff board.

(c) Mission-area analysis experts in each mission area were detailed to support each panel.

(d) The mission-area analysis staff prepared summary capability displays and major sections of the program objective memorandum.[14]

The approach to mission-area analysis in 1978 is the basis for the current approach. It is a synthesis of the Air Force research and development prototype and initial plans and operations methods, and the philosophy of war-fighting capability articulated in the document containing long-range capability objectives signed by the Chief of Staff of the Air Force in 1977. The following paragraphs examine this version of mission-area analysis and key improvements for the 199 mission-area analysis cycle.[15] The *Air Force Planning Guide* resulting from the 1979 cycle was published on 1 December 1979 to support development of the program for fiscal years 1982-86.

At its highest level of abstraction, the model used in the current version of mission-area analysis examines the capability needed to conduct central and theater warfare. The model applies a systems concept that views the capability to conduct these two classes of warfare as transient groupings of capabilities to

14. Report to the Assistant Secretary of the Air Force (Financial Management), "How MAA Was Used in FY 1981 POM Development," HQ USAF/XOXFI, 11 July 1979.

15. The descriptive material on the current MAA model is drawn largely from discussions with, and notes of, Lt. Col. Nick Fritz, HQ USAF, XOXFI.

achieve specific operational objectives in a particular environment. The capability to conduct war is based on the capability to orient, engage, and implement the warfare system. Orientation is the process by which command elements *observe, interpret,* and *adapt* to the environment. Engagement is the integration of delivery vehicles, munitions, and trained personnel to accomplish specific combat tasks. Implementation is the process of regenerating and sustaining the warfare system over a given period.

Based on this concept, *the specific structure* for analysis encompasses all Air Force activities under five major areas: central conflict engagement, theater conflict engagement, force projection, orientation, and implementation. Each major area is further subdivided into mission areas. Central conflict includes strategic offense and strategic defense. Theater conflict includes counterair, defense suppression, close air support, interdiction, special operations, and collateral missions. Force projection includes aerial refueling, airlift, and space transportation. Orientation consists of various outputs necessary to control and focus weapons systems—threat assessment, strategic warning, tactical warning, force status, immediate targeting and weapon control, navigation guidance, communication, etc. Implementation involves functions that sustain and regenerate combat capabilities—personnel processes, combat rescue, medical services, security, logistics, technology development, and system acquisition. Additionally, a number of fundamental tasks and subtasks must be performed in each of these mission areas.

The various *conditions and scenarios* in which the mission, tasks, and subtasks must be performed further differentiate the hierarchy. In theater conflict, for example, the model differentiates among the conditions of day clear, night clear, layered/obscured, and in-weather. The orientation conditions include peace, crisis, transattack, and postattack. Additionally, *representative scenarios* that embody the consolidated guidance of the Secretary of Defense are incorporated in each mission-area hierarchy.

The structure is complete when each node in the network is weighted to reflect its criticality in accomplishing superordinate nodes—higher aggregations of tasks and missions, conditions, and scenarios. The entire structure is then replicated to cover a 15-year planning horizon for a total of three 5-year segments, beginning within the program period and extending through the end of the planning horizon for the extended planning annex to the program objective memorandum.

This detailed task/condition and time-frame differentiation and weighting permits assessments of specific Air Force capabilities. When the task has been fully defined in the analytic structure, management sets an objective and assesses capability against this objective. At this lowest level of detail, judgments can be

based on a comparison of needed capability (the objective) and existing system performance. This comparison provides an index describing the degree to which existing capability meets the objective. These assessments are aggregated at successive levels in the hierarchy according to the weights reflecting their criticality, and the specific relationships among the assets that yield capability.

The lessons learned in applying the above approach to the preparation of the program objective memorandum for fiscal year 1981-85 led to two significant improvements in the mission-area analysis used in preparing the program for fiscal years 1982-86. The first improvement was the restructuring of the analysis activity into five phases, each with a discrete product. This restructuring allows sufficient opportunity for leaders to review the analysis in comprehensible (bite-size) segments, and provides adequate time to synthesize conflicting points of view. Phase I includes a review and validation of the mission structure, the objectives in each area, and the relevant conditions and scenarios. Phase II focuses on defining enemy threats applicable to each mission area and scenario, and allocating current U.S. capability against these enemy forces. During Phase III, the most time-consuming step in the process, mission analysts assess U.S. capability in each specific task at the lowest level of the network. In Phase IV, they document these assessments in the draft *Air Force Planning Guide*. They publish the final version of the Guide in Phase V, and focus on helping the functional and corporate elements of the Air Staff apply the findings to decisions concerning resource allocation and acquisition. The move to a more measured process has allowed better participation across the Air Staff and the major commands. The result is an improved planning guide.

The second improvement concerns the analytic method used to synthesize certain types of capability assessments. In the approach outlined above, analysts made assessments at the lowest level of each network regarding the contribution to overall capability of specific weapons systems. On the basis of subjective judgments, these assessments were then totaled and ranked as to the importance of one system in relation to all other systems. This process diluted the importance of any one weapon system, and blurred the distinction between the quality of a system and the quantity in which that system was deployed. To mitigate these shortcomings, specific weapons systems were moved to a higher level in the network.

The lowest level of the network now includes observable data which, when totaled, show the number of sorties that can be generated and the probability of destruction for each sortie. When multiplied together, this aggregate figure yields the expected target-kill potential of each specific weapon system. Finally, the contributions of all relevant systems are combined and compared with the target-kill objective to produce the index of capability for that mission or task. By focusing

more clearly on the value of individual systems, this change in methodology has greatly improved the applicability of mission-area analysis to decisions on resource allocation among existing systems, and to choices of systems among competing development efforts.

The above approach, including recent improvements, is only one of many possible analytical techniques; it is designed to balance rigor with practicality, reality with reproducibility, and specific focus with general applicability. It appears to be highly successful, and meets the goals set forth in the memorandum of understanding outlined earlier. Moreover, the current approach to mission-area analysis provides a framework for rational dialogue among planners, programmers, and budgeteers in allocating limited resources. It provides a consistent and comprehensive baseline of prioritized needs for the initiation of system acquisitions. Finally, and most important, it provides increased understanding of Air Force capability in all segments and at all levels of authority.

Despite its successes, however, mission-area analysis presents a number of problems. The size and complexity of the model causes some difficulty in use. Decision-makers at the working level find the level of detail overwhelming unless they can work full time with the model. The improvements outlined above should alleviate this situation when they are fully understood and used, and they should help establish an effective middle ground at the senior level between the amount of detail and the level of specificity necessary to allow for effective communication. These problems in using mission-area analysis could be fatal if, after a fair trial, the model makes no apparent imprint on the budget. This fatal flaw has hampered prior efforts.

If mission-area analysis does not make such an impact, we must then raise a devastating question for management. What process can be used to answer, in a traceable manner, the following sequence of questions:

—What guidance will be provided?
—What does that guidance mean in terms of military outputs to be produced?
—What is the current and programmed capability to do those tasks?
—What is the relative importance of making up the shortfalls in capability?
—What are the affordable solutions given varying levels of fiscal constraint?

Unlike the prototype developed under the Deputy Chief of Staff, Research and Development, current mission-area analysis is not yet an integral part of the resource allocation process in the Air Staff. The cosmetics of integration are present, but real integration has not yet been achieved. The Vanguard process used by the Air Force Systems Command is one application of the mission-area analysis concept where complete integration is evident.

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The Vanguard Process

As stated at the beginning of this discussion, Vanguard is a promising application of mission-area analysis to decision-making in resource allocation and acquisition planning, General Slay, Commander of the Air Force Systems Command, expressed the reasons succinctly in his introduction to the AFSC pamphlet on Vanguard:

> When Vanguard comes fully of age, it will encompass in a living, breathing, dynamic way, every dime that is being or will be spent by AFSC. It will provide us with a fully integrated planning continuum across the entire spectrum of our activities. This plan will serve as the template against which we do short-range programming, budgeting, and measurement. Vanguard will actually be our command roadmap with its roots firmly implanted in overall Air Force plans and objectives and the stated needs of our customers, and the other Air Force major commands. It will be the mechanism for viewing individual programs in total context—as systems of systems structured to perform mission tasks.[16]

The Vanguard process derives its strength from the balance it achieves between analysis, planning, and resource allocation. General Slay's directive indicates that it was designed with the lessons of earlier ventures clearly in mind: "The end-all of Vanguard is the budget, the POM, the FYDP. There's where we can and must have our influence."[17]

Vanguard begins with a capability analysis similar to mission-area analysis. First, the overall Air Force mission is divided into mission areas, which are further subdivided into functions and tasks to reach a comprehensible level of abstraction. Each segment of the resulting network is then assigned an importance weight to reflect the relative criticality of each element in accomplishing the mission. The enemy threat is overlaid on this structure to define the needed capability in each area. With these needs in mind, analysts examine current U.S. forces to assess immediate deficiencies in capability, and, to assess future shortfalls, they examine projected U.S. forces in the light of the projected enemy threat. The unsatisfied needs that result from a comparison of the outcome of these last two steps are prioritized through use of the assigned importance weights. This priority list becomes the basis for planning future developments.

There are many apparent similarities between the analysis portion of Vanguard and the mission-area analysis described earlier. This is not surprising

16. Air Force Systems Command Pamphlet, "VANGUARD," XQ AFSC/XR June 1979, p. 1.
17. *Ibid.*, p. 4.

more clearly on the value of individual systems, this change in methodology has greatly improved the applicability of mission-area analysis to decisions on resource allocation among existing systems, and to choices of systems among competing development efforts.

The above approach, including recent improvements, is only one of many possible analytical techniques; it is designed to balance rigor with practicality, reality with reproducibility, and specific focus with general applicability. It appears to be highly successful, and meets the goals set forth in the memorandum of understanding outlined earlier. Moreover, the current approach to mission-area analysis provides a framework for rational dialogue among planners, programmers, and budgeteers in allocating limited resources. It provides a consistent and comprehensive baseline of prioritized needs for the initiation of system acquisitions. Finally, and most important, it provides increased understanding of Air Force capability in all segments and at all levels of authority.

Despite its successes, however, mission-area analysis presents a number of problems. The size and complexity of the model causes some difficulty in use. Decision-makers at the working level find the level of detail overwhelming unless they can work full time with the model. The improvements outlined above should alleviate this situation when they are fully understood and used, and they should help establish an effective middle ground at the senior level between the amount of detail and the level of specificity necessary to allow for effective communication. These problems in using mission-area analysis could be fatal if, after a fair trial, the model makes no apparent imprint on the budget. This fatal flaw has hampered prior efforts.

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since both processes are founded in multiattribute utility theory, and both address the same subject—Air Force capability. But, there are also some significant differences between the two efforts: Air Force-wide mission-area analysis is a generalized model, but Vanguard focuses specifically on decisions related to research, development, and acquisition; mission-area analysis uses common scenarios and threat data, but the scenarios and data used in Vanguard are individualized for use by each area analyst. This distinction allows for a better interface between mission-area analysis and a variety of users, such as the logistics, personnel, and force planning communities, but Vanguard is "hardwired" to the development planner. Although this flexibility is an advantage for mission-area analysis, it represents a significant price. The user of mission-area analysis must be extremely knowledgeable to track through the complex network structure, while the logic of Vanguard is simpler and easier to follow. This difference is crucial in the application of the respective analyses to decision-making.

Vanguard is most promising in applying the results of analysis to decision-making. The prioritized list of unsatisfied needs prepared by each analyst is the starting point for the next task—the first step in the application process. The analyst prepares a baseline plan depicting the essential characteristics of all existing and planned programs that contribute capability in a given area. Of particular interest is the time phasing and interrelationship of complementary efforts. The analyst then compares the baseline plan with the deficiency list and prepares a set of alternatives to correct outstanding deficiencies. These alternatives are grist for the AFSC corporate structure in formulating the initial research, development, and acquisition program for review by the Air Staff.

This already difficult task is complicated by the necessity of including, in every step, the users in the operational commands and the program managers in the AFSC product divisions. The analyst must be sure that the user supports his perception of the need, and that the baseline plan and alternatives are consistent with the realities that govern feasible choices for the program manager. The AFSC corporate structure must preserve this essential congruency as it prioritizes across mission areas and imposes fiscal constraints.

Although Vanguard is still in the early stages of implementation, it has shown promising results. Nevertheless, we must give careful attention to the make/break condition brought out in every management planning and control test: top management must be involved. As long as the aligning force continues, Vanguard will no doubt live up to General Slay's desire that "Vanguard should reflect, at any level of detail, a way to determine where you stand, where you

have to go, and how much it costs to get there."[18] Management must not overlook this lesson when it consideres an approach for the future.

A New Management Approach

I have examined in broad terms some of the requirements that should be satisfied by the Air Force management process. The single most important consideration is the necessity for making resource-allocation decisions with undisputed awareness of their impact on military outputs; that is, future force capability. Management needs a process that ties these decisions to mission needs in a way that fosters optimum capability for the total Air Force program over the short, medium, and long term. This objective can be achieved only by prioritizing new and ongoing programs and activities, selecting programs and activities that will be funded, and then effectively justifying these selections to higher authority. Finally, to ensure that decisions are made from legitimate alternatives, all new system-acquisition initiatives must be based on a well-defined and validated need. The best approach to satisfying these complementary requirements centers on the effective use of mission-area analysis.

The concept of mission-area analysis is not new; its current use dates from at least the late 1960s. There have been attempts to implement the concept over the past 10 years, but most efforts have focused on the technical aspects of the analysis itself. As a result, the Air Force possesses a well-tested, comprehensive, and detailed analytic tool for use within the air staff and the major commands.

Management analysts are continually isolating and overcoming the flaws in this tool, but they have not made significant progress in effectively applying it to resource-allocation decisions. For the decision cycles prior to, and including, preparation of the President's budget for 1981, we cannot draw a visible and traceable analytic threat from capability needs to the enacted Air Force budget. There are indications of recent progress on this score in the planning for the FY 1982-86 program objective memorandum cycle. The most promising indicator is a shift toward a mission alignment within the panels of the Air Staff board.

The chairman of the Program Review Committee highlighted this shift in his initial fiscal year 1982-86 program objective memorandum preparation tasking to the panel chairmen on 1 October 1979:

> Prime mission panels will brief the PRC first, setting the stage for the POM development. The functional panels which provide a prime supporting role to the mission areas (RDT&E, WRM, Sup-

18. *Ibid.*, p. 10.

> port) will brief second. Their presentations should show the interrelationship to the mission areas. The functional panels which serve in an overseeing role (Aircrew Training, RECON/Intelligence, Defense Suppression/EW, Data Automation) will brief third. Their briefings should show the supporting relationship to each of the mission areas.[19]

The history of mission-area analysis teaches one inescapable lesson: The concept will not survive if it does not have a significant impact on basic resource allocation decisions. A new approach must integrate mission-area analysis into the mainstream of the decision process. Such an approach requires neither revolutionary changes nor reorganization, but it does require shifts in emphasis and refocusing of effort. The emphasis should shift throughout the decision hierarchy toward the use of the mission approach to structure, support, and defend resource allocations. Staff efforts at all levels should focus on the type of planning embodied in the Vanguard philosophy.

More specifically, the major operating commands should construct integrated plans that encompass all resource categories and cover a 15-year planning horizon. Within reasonable fiscal limits, these plans should balance readiness and modernization needs from the perspective of the commander. The foundation for these plans should be the analysis performed in support of Air Force-wide mission area analysis for the Deputy Chief of Staff, Plans, Operations, and Readiness. Furthermore, this major-command effort should support the initiation of new weapon system acquisitions and the planning conducted under Vanguard, which then becomes the baseline modernization plan for the Air Force.

To fulfill this role, the Vanguard effort must continue to reflect the perspectives of both the user and the program manager. Because resource allocations are largely the responsibility of the Air Staff, Vanguard must be given a closer relationship with the decision-making processes at the Pentagon. This does not mean that Vanguard should be subordinated in any way—the opposite is probably true. Rather, it means that the results of the Vanguard analysis should be consistent with the results of the mission-area analysis conducted in major commands and throughout the Air Force. This consistency can be achieved by linking the timetables of these efforts, and by requiring a review and comparison of each analysis by the Deputy Chief of Staff, Research, Development and Acquisition.

The Air Staff, as well, should make some shifts in emphasis to take full advantage of this definitive planning within the major operating commands and the Air

19. HQ USAF/CVSB, Letter to Air Staff Board Panel Chairmen "FY 82-86 POM Development," 1 October 1979, Attachment 1, p. 3.

Force Systems Command. More specifically, the various Air Staff panels should review, rather than create, the resource allocation plan for each mission area. Functional staffs should be responsible for creating these plans. The shift in responsibility should not be interpreted as the last breath of the panels, but it should recognize that line managers must be held accountable for planning, and that the strength of corporate bodies lies in their ability to review. The panels must not be allowed to atrophy within the resource allocation process, especially when their role involves integrating and balancing across mission areas. The role of panels as reviewers and inquisitors is the key to the success of the mission-oriented process. The functional panels must continue to ensure full consideration for such generic technical areas as armament and avionics.

Refocused planning activity within the functional staffs must begin with the objective capabilities resulting from both the Air Force-wide mission area analysis, and the long-range planning process conducted by the Air Force Chief of Staff and the Secretary of the Air Force. From this common beginning, the staff elements would create detailed plans within their areas of specialization. For example, the Deputy Chief of Staff, Research and Development, would create the modernization plan; the planners would create the force plan; and the legislation would create the support plan, etc. The panels would perform coordinating functions in addition to their responsibilities for review and recommendation. The ongoing Vanguard process would make this shift in emphasis relatively straightforward in Air Force research and development; and the existing objective force process under the Deputy Chief of Staff, Plans and Operations, could be modified to produce a mission-area force plan with relative ease. The shift in logistics might be more difficult, but, even in this area, work is in progress to model the entire logistics functions in terms of outputs like sortie generation capability for theater engagement assets and utilization rates for aircraft assets.

The shifts in emphasis recommended above would require a number of procedural and administrative changes. One change is crucial because it will significantly affect the interface between the Air Force and the Department of Defense; that is, the selection of appropriate mission categories. If a process based on mission-area analysis is to work efficiently within the Air Force, everyone must use the same framework of missions, tasks, and functions. This homogeneity does not preclude tailoring different structures to resolve a specific problem; rather, it means that variances outside the mainstream of the decision process would be permitted only as a cross-check from a different perspective. This logic also applies to the Department of Defense and, ultimately, to Congress.

Although there is little hope of changing the congressional approach, there is a strong possibility that the Department of Defense can be persuaded to adopt a

single-mission structure for resource allocation decisions, especially with the advent of the Defense Resources Board. In fact, the move toward such a structure has already begun, to the extent that the services now use the Department of Defense mission categories for program objective memorandum submission and budget presentation to Congress. The Air Force should accelerate movement in this direction. Without a single structure, the Air Force will inevitably continue to defend its decisions to the Department of Defense on a program-by-program basis, rather than at the more appropriate mission level where assigned responsibility and force capability are the media of exchange.

It is time for the Air Force to take the next step in the evolution of the management of resources—fully integrate mission-area analysis into the resource-allocation process. The Deputy Chief of Staff, Operations, Plans, and Readiness, has proved the feasibility of the analysis. With Vanguard, the commander of Air Force Systems Command has proved that mission-area analysis can be the basis for planning and resource allocation. The benefits of this new management approach have been identified throughout this discussion: better and more defensible decisions for the near term, and a better grasp on the need and affordability of long-term capability.

A Functional View of Organizations

102

Paul O. Ballou

The traditional approach to organizing has been a pyramid structure in which all decision-making power flows from top down. In the early 1900s, Frederick Taylor greatly influenced organizational structures used today with his theory of "scientific management." As an engineer, Taylor advocated a "best way" approach for the accomplishment of management's tasks. Accordingly, organizational structures have been developed to achieve maximum efficiency and production within each organizational unit.

Within the past 20 to 30 years, a profound change in the main task of management has been emerging as a result of technological growth, information systems, and social expectations of government and industry. The trend in organizations has been away from a fixed bureaucratic hierarchy toward one that is flexible and functional according to its needs. This article deals primarily with the administration of certain types of formal organizations, although some of the propositions and theories are probably applicable to all types of organizations.

It is difficult to define a formal organization in precise terms. Organizations are social inventions or tools developed to accomplish objectives not achievable any other way. They take a variety of people, knowledge, and usually materials, and give them structure and systems to become an integrated whole.

Organizations in which most managers operate are social systems comprising many interrelated subsystems. Figure 1 depicts subsystems which influence accomplishment of organizational goals. The focus of the administrative/structural subsystem is on authority, structure, and responsibility within the organization: "Who does what for whom" and "who tells whom to do what, when and why." The informal decision-making subsystem emphasizes key decisions and their informal needs to keep the system going. The main concern of the economic/technological subsystem is on the work to be done. Although the focus of the human/social subsystem is on the motivation and needs of the members of the organization, it should be emphasized that within a systems approach there is a clear understanding that changes in one subsystem effect changes in other parts

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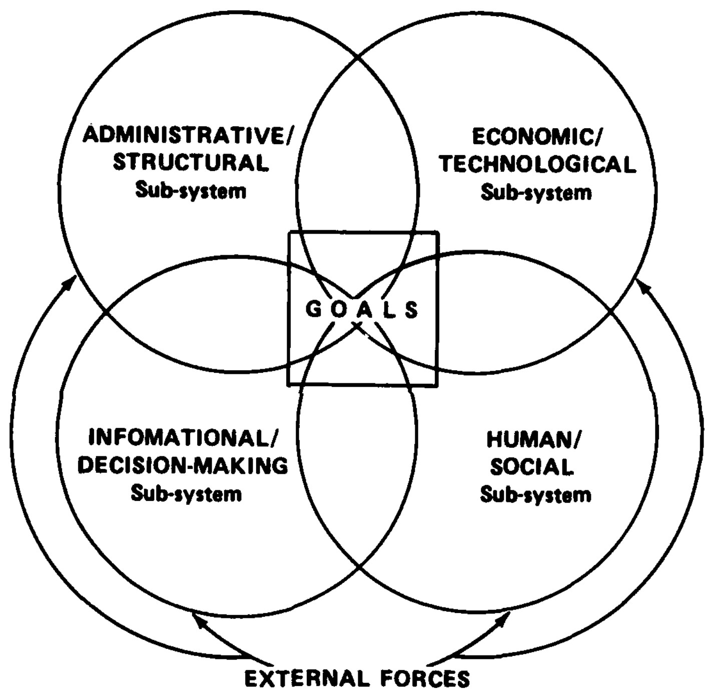
FIGURE 1
The Interrelated Sub-Systems of an Organization



of the total system.[1] The ultimate purpose of an organization is to establish conditions that will enhance the effectiveness of the organization in attaining its goals.

Administrative/Structural Subsystem

In designing the building blocks of organization, four questions face the organizer.

—What should the units of organization be?

1. Paul Hersey and Kenneth H. Blanchard, *Management of Organizational Behavior: Utilizing Human Resources* (Englewood Cliffs, N.J.: Prentice Hall, 1977), p. 8.

—What components should join together, and what components should be kept apart?
—What size and shape pertain to different components?
—What is the appropriate placement and relationship of different units?[2]
Identifying key activities and analyzing their contributions defines the building blocks of organizations.

Structure implies the distribution of functions. When all the functions within an organization are seen within the perspective of the whole, they reflect an allocation of responsibilities or duties in the functional areas of planning, direction, control, organization, innovation, or administration. The structure of an organization may be viewed as complex building blocks that represent a configuration or distribution of activities for each major area of organizational effort. The level of authority in one function differs from that of other functions, in time for planning, scope, ability to make commitments, and span of control.

MONOCRATIC CONCEPT

The traditional monocratic, bureaucratic concept of organization is defined as a pyramidal, hierarchical organizational structure in which all decision-making power flows from superordinates to subordinates. This concept has been described by Weber.[3] He is definitely at one end of the continuum. There is no question where responsibility lies under his concept. Authority can be delegated, but responsibility cannot be shared. The superordinates have power and can force decisions on subordinates, who are considered to be expendable.

The leadership is confined to those holding positions of power in the echelon. The individual finds security in a climate in which superordinates protect the interests of subordinates. Since the superordinate will protect his subordinates, right or wrong, his subordinates owe him their loyalty. This loyalty requires that subordinates defend him and also accept his decisions without question. This is also an essential assumption of the feudal system.

Weber's authoritarian concept has been severely criticized, but it is the prevailing model of organization found in every advanced country of the world, regardless of its political philosophy or economic organization.

PLURALISTIC CONCEPT

Unfortunately, no scholar with the brilliance of a Weber has attempted to

2. Peter F. Drucker, *People and Performance: The Best of Peter Drucker on Management* (New York: Harper & Row, 1977), p. 177.
3. Max Weber, *The Theory of Social and Economic Organization*, trans A.M. Henderson and Talcott Parsons, ed. Talcott Parsons. (New York: Free Press of Glencoe, 1947).

describe the model for the pluralistic concept. The emerging pluralistic concept of organization can best be described as a modification of the monocratic concept, providing for a pluralistic sharing of the power to make policy and programs on a collegial basis. Under this concept, the organization is structured hierarchically, as in Weber's bureaucracy, to complement programs and policies, and is structured collegially on an egalitarian basis for making policy and program decisions. Thompson believed that:

> If formal structures could be sufficiently loosened, it might be possible for organizations and units to restructure themselves continually in the light of the problem at hand. Thus, for generating ideas for planning and problem solving, the organization or unit would unstructure itself into a freely communicating body of equals. When it came time, the organization would then restructure itself into the more usual hierarchical form, tightening up its lines somewhat.[4]

Some of the assumptions underlying the pluralistic concept differ sharply from those underlying the monocratic concept. First, leadership is not confined to those holding status positions in the power echelon; rather, any person can provide it. Second, good human relations improves group morale, and high group morale generally facilitates production. Third, responsibility as well as power and authority can be shared, and those affected by a program or policy should share in decision-making on that program or policy. Lastly, a person finds security in a dynamic climate in which he shares decision-making responsibility, and maximum production is attained in a threat-free climate.

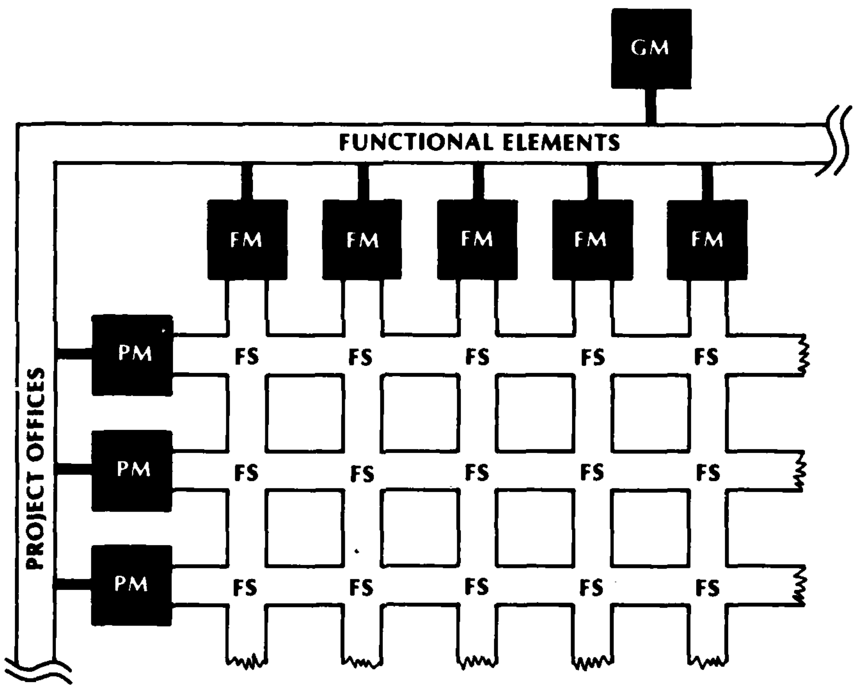
MATRIX CONCEPT (AD HOC FORM)

The organizational structure under both the monocratic and pluralistic concepts are functional by work input. Each department is assigned specific responsibilities within its technical discipline, with integration responsibility at a higher echelon within the organization. A new matrix organization concept is being developed which changes these traditional patterns by creating new vertical, horizontal, and diagonal relationships among the organization's members. Goal orientation also changes for the functional members of the matrix in that they become concerned with the project in addition to their more familiar functional goals. It is the synergism resulting from these interactive relationships that

4. Victor A. Thompson, "Bureaucracy and Innovation," *Administrative Science Quarterly*, 10, No. 1, June 1965.

underscores the uniqueness of the matrix concept. The organizational locations of the managers and the functional specialists are illustrated in Figure 2.[5] The project

FIGURE 2
Matrix Organization



LEGEND:
GM—GENERAL MANAGER
PM—PROJECT MANAGER
FM—FUNCTIONAL MANAGER
FS—FUNCTIONAL SPECIALIST

5. William C. Wall, Jr., "The General Manager of Matrix Organization," *Defense Systems Management Review* (Spring, 1980), p. 7.

manager's primary task is one of integrating subprogram elements into a unified total program of the organization without breaching cost, schedule, and technical performance thresholds.

Informational/Decision-Making Subsystem

Every organization must make provisions for decision-making. Decisions must be made concerning goals, purposes, objectives, policies, and programs to be accepted as legitimate by the organization. Decisions need to be rendered continuously with respect to the implementation of policies and programs.

The decision-making processes are so vital to the understanding of administration and organization that significant progress has been made in their theoretical analysis. Simon has suggested that understanding of the application of administrative principles is to be obtained by analyzing the administrative process in terms of decisions.[6] He theorized that the effectiveness of organizational decisions could be maximized by increasing the rationality of organizational decisions.

Griffiths presented the view that the central process of administration is decision-making. He presented a set of concepts on decison-making, perception, communication, power, and authority, and formulated the following major propositions:

—The structure of an organization is determined by the nature of its decision-making process.

—If the formal and informal organization approaches congruency, then the total organization will approach achievement.

—If the administrator confines his behavior to making decisions on the decision-making process rather than making terminal decisions for the organization, his behavior will be more acceptable to his subordinates.

—If the administrator perceives himself as the controller of the decision-making process rather than the maker of the organization's decisions, the decision will be more effective.[7]

These propositions further demonstrate the interrelated subsystems of an organization depicted in Figure 1.

Economic/Technological Subsystem

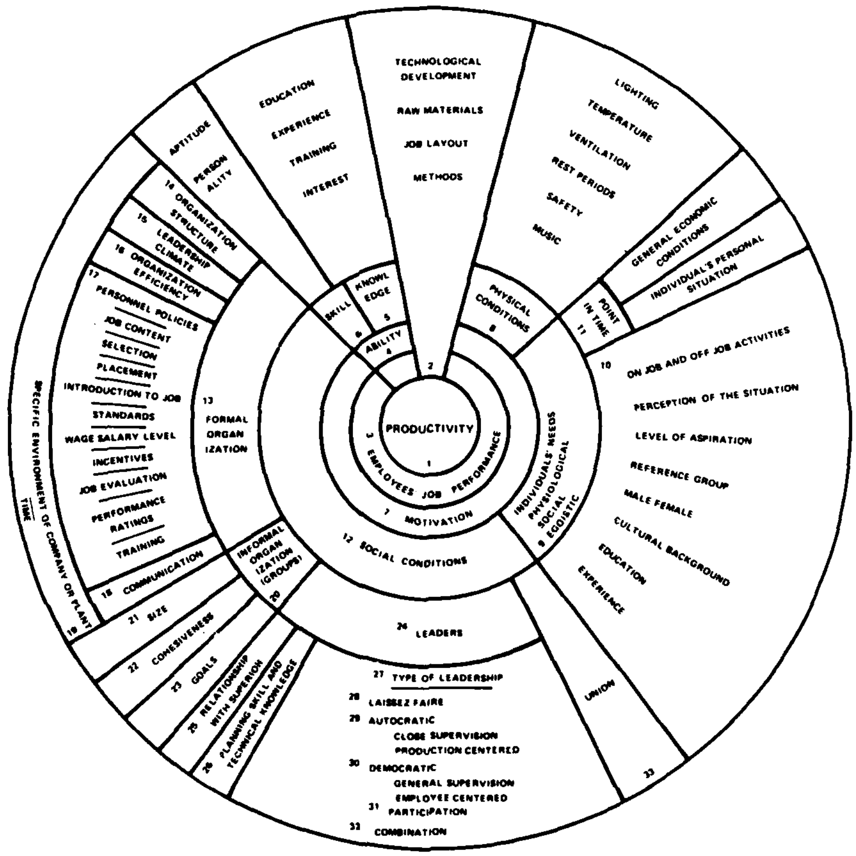
Organizational goals and objectives determine what is to be produced. The

6. Simon, Administrative Behavior, p. 240.
7. Griffiths, Administrative Theory, pp. 89–91.

organization must provide for determination of the roles of each member. When people are forced together, they cannot become effective until common goals have been determined. If there are multiple goals, they must be placed in clear priority to avoid conflict. The goals must include those of individual members as well as those of the organization if it is to maximize its production possibilities.

The effectiveness of an organization is enhanced when every person in the

FIGURE 3
Productivity



organization knows his responsibilities. Unless the lines of responsibility and authority are clearly defined, chaos is inevitable. Further, no individual in the organization should be compelled to take direct orders from more than one person or conflict will inevitably arise (unity of command).

The effectiveness of an organization is further enhanced by the division of labor and task specialization to increase productivity. Much of the increase in productivity during the past two centuries has been due to the formation of large complex organizations that have applied the division-of-labor principle. Figure 3 emphasizes productivity as a primary goal of an organization.[8]

The diagram indicates that greater productivity depends upon or is determined by technical factors (technological development, raw materials, job layout, methods, etc.), human factors (motivation, needs, leadership), and some important other factors affecting employees' job performance. There are a large number of such factors. Most of them affect other factors in the diagram and are themselves affected by others. Thus, there is an extremely complex interdependency among them.

Features of the operating or work system emerge for furnishing a product or service, but they also are sensitive to the external environment. If the environment is varied, the organization must develop specialized subunits to deal with each major part of this environment. The more successfully this match is made, the more successful the organization will be, but the more differentiated the subunits will become from each other.

A successful organization is not just a collection of well-accomplished subobjectives. It is also a set of successful subobjectives integrated into a whole. Manufacturing departments producing products economically is one thing; but producing them at the time customers need them and making variations to fit customers' needs, is another. Designing new products in one thing, but designing them in such a way that they can be made readily with existing productive facilities, or so they can be easily maintained by the customer, is something else. Successful organizations are those that achieve good integration between their various subunits. Each subunit of an organization, having different environments, objectives, and technologies, develops sets of commitments and outlooks peculiar to themselves.

Human/Social Subsystem

Managers are only beginning to realize that their most important assets are

8. Robert A. Sutermeister, *People and Productivity* (New York: McGraw-Hill, 1969), p. 1.

human resources. Many of our most critical problems lie in the conflict between organizational units and the inability of individuals to cooperate.

Many organizational concepts lead to assumptions about human nature that are incompatible with the proper development of maturity in human personality. Argyris sees a definite incongruity between the needs of a mature personality and the formal organization as it now exists.[9] Since he implies that the classical theory of management (based on Theory X assumptions) usually prevails, management creates childlike roles for workers that frustrate natural development. Argyris challenges management to provide a work climate in which employees have a chance to grow and mature as individuals, and as members of a group. Employees must be able to satisfy their own needs while working for the success of the organization. Implicit in this is the belief that people can be basically self-directed and creative at work if properly motivated and that, therefore, management based on the assumption of Theory Y will be more profitable for the individual and the organization.[10]

Frederick Herzberg has developed a motivation-hygiene theory.[11] He has concluded that when people feel dissatisfied with their jobs, they are concerned about the environment in which they are working or about hygiene factors, e.g., policies and administration, supervision, working conditions, interpersonal relations, money, status, security. On the other hand, when people feel good about their jobs, this has to do with the work itself, or motivators, e.g., achievement, recognition for accomplishment, challenging work, increased responsibility, growth, and development. What we really need to do with work, Herzberg suggests, is to enrich the job. Job enrichment means deliberate upgrading of responsibility, scope, and challenge in work.

The successful organization has one major attribute that sets it apart from unsuccessful organizations: dynamic and effective leadership. Leadership involves accomplishing goals with and through people. Therefore, a leader must be concerned about tasks and human relationships. Rensis Likert did extensive research to discover the general pattern of management used by high-producing managers.[12] He found that "supervisors with the best records of performance focus their primary attention on the human aspects of their subordinates'

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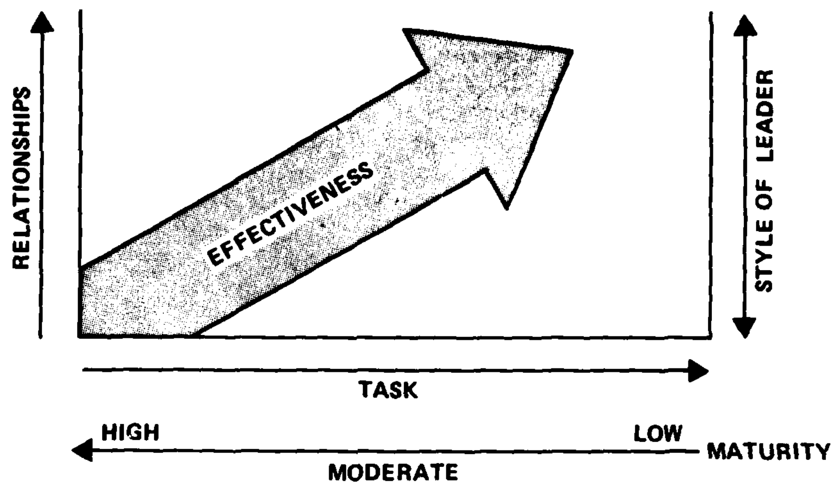
9. Chris Argyris, *Management and Organizational Development* (New York: McGraw-Hill, 1971), p. 12.
10. Douglas McGregor, *The Human Side of Enterprise* (New York: McGraw-Hill, 1960).
11. Frederick Herzberg, Bernard Mausner and Barbara Synderman, *The Motivation to Work* (New York: John Wiley & Son, 1959).
12. Rensis Likert, *New Patterns of Management* (New York: McGraw-Hill, 1961), Chapter 8, pp. 97-106.

FIGURE 4
Adding an Effectiveness Dimension



problems and on endeavoring to build effective work groups with high performance goals."[13] The more managers adapt their style of leader behavior to meet the particular situation and the needs of their followers, the more effective they will be in reaching personal and organizational goals. This is illustrated in Figure 4.

Evaluation

A great deal of research is being done to bring more light on the intricacies of organizational structure. Classical approaches based on different functional features of organizations have proved inadequate to describe their complex environments. We have seriously lagged in conceptualizing organizational relationships and processes, and until they are better understood, more systematic approaches will make little headway. However, it is clear that contemporary approaches are starting to take hold, and we can view the future optimistically.

We must learn to build organizations that are held together not by rules and

13. *Ibid*, p. 7.

standard procedures, but by the forces of individual and group identification with organizational goals. Organizations must become increasingly aware of their responsibilities toward individuals and toward the environment. Managers performing within complex, changing environments must increasingly operate from a flexible base of perspectives, tools, and approaches. Further complexity is likely as interactions and dependency between economic, governmental, and community units and bodies grow and as work embodies more advanced technologies and procedures. ||

Correspondence

Dear Sir:

Your article, "The Maturing of the DOD Acquisition Process," in the Summer 1980 *Defense Systems Management Review* is most valuable in pulling together the many facets bearing on the acquisition process and in providing a succinct historical review of how we arrived in today's environment. The article is and will be very helpful to those coming into this business in the future, as well as filling in gaps of knowledge of those of us who have been in it for years.

Harry R. Ketcham
RCA

Dear Sir:

I want to compliment you for the recent article in the *Defense Systems Management Review* on "The Maturing of the DOD Acquisition Process" [Summer 1980]. It is indeed an excellent summary of three decades of DOD weapon system management. In spite of all the problems associated with the management of defense programs, one must place the process in its proper perspective. Several years ago I had the opportunity of attending the Brookings 1-week course on "Federal Operations for Business Executives." Compared to other elements of the Federal Government, I found DOD management techniques to be far more sophisticated, and I feel DOD can be proud of its efforts. This is not to say that things cannot be improved, but once in a while let's "look at the doughnut and not the hole."

I feel the most serious problem in system acquisition today is the extreme extension of the acquisition cycle due to rules, regulations, and an entrenched bureaucracy. There is hope because I perceive an awareness of the problem in both DOD and Congress.

Again, my congratulations on a most informative article.

Welko E. Gasich
Senior Vice President—Advanced Projects
Northrop Corporation

Dear Sir:

I just completed reading the article, "The Maturing of the DOD Acquisition Process" in the summer issue of the *Defense Systems Management Review*. Congratulations! ! It was excellent—a real service to the community.

Don Earles
Missile Systems Division
Raytheon Company

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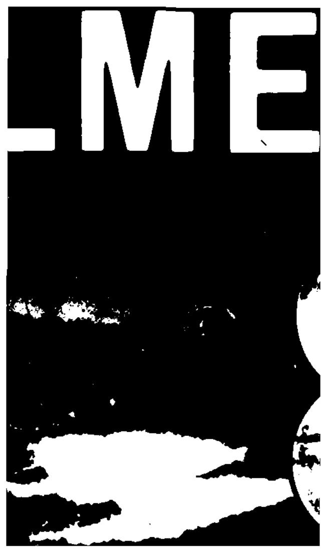
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